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FIRE CONTROL NOTES

A PERIODICAL DEVOTED
TO THE TECHNIQUE OF
FOREST FIRE CONTROL

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FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and techniques may be communicated to and from every worker in the field of forest fire control.

Volume 17 Number 4

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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FIRE HAZARD RESULTING FROM JACK PINE SLASH[1]

D. E. WILLIAMS
Research forester, Forestry Branch Head Office, Ottawa

INTRODUCTION

The accumulation of slash during logging operations introduces a serious problem to those concerned with fire control. Not only are fires more likely to start in slash areas but once ignited they have a greater resistance to control and often do more damage than fires burning in an uncut forest. Slash is treated in a number of ways depending usually on the cutting method. Essentially, there are two main treatments—leaving the slash on the cut-over area, or removing it by burning. Further, the manner in which the slash is left has an effect on the subsequent fire hazard.

The comparative fire hazard of areas of burned and unburned slash was investigated by Munger and Matthews (*6*)[2] and they concluded that unburned slash in western Washington and Oregon is one-third more hazardous than burned slash 10 years after logging. Cheyney (*2*), on the other hand, writes in the Journal of Forestry: "It would be a conservative statement to say that no slash is a special fire hazard in the Lake States for more than 5 years after it is cut." There appears to be no doubt, however, that an accumulation of slash in a cut-over forest will increase the fire hazard of the area for a considerable period after cutting operations have been completed. Further, it is evident that in any locality the increase of hazard brought about by the presence of slash will vary somewhat with the method of slash treatment employed, and with the number of years which have elapsed since cutting took place.

The Federal Forestry Branch, in co-operation with the Manitoba Forest Service, conducted a series of large-scale test fires in slash areas in the Sandilands Forest Reserve. The object of the study was to determine experimentally, (a) the comparative fire hazard in jack pine in similar cut-over areas where different slash treatments had been employed and, (b) the variations in hazard which occur as slash ages. The term "slash age" will be used to refer to the number of years since logging.

This study also provided an opportunity for an investigation of the effect of slash disposal methods on jack pine regeneration. The results of this investigation are described by H. J. Johnson in a current publication of the Federal Forestry Branch (*4*).

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[1] An article of this title appeared in its entirety in 1955 as Forest Research Division Technical Note 22 of the Forestry Branch of the Canada Department of Northern Affairs and National Resources, Ottawa. A somewhat shortened version is published here through the courtesy of the author and the Forestry Branch.

[2] Italic numbers in parentheses refer to a list of References, p. 8.

DESCRIPTION OF AREA

The Sandilands Forest Reserve lies near the southeast corner of Manitoba at the western extremity of Halliday's (*3*) Great Lakes-St. Lawrence Forest Region. The topography is flat and the soil is sandy. Stands of jack pine (*Pinus banksiana* Lamb.), the most important commercial species in the area, are typically very open and consequent heavy branching results in moderate to heavy slash accumulation during logging operations. High underbrush is very scattered and other vegetation is moderate with bearberry (*Arctostaphylos uva-ursi*), blueberry (*Vaccinium* spp.) and caribou moss (*Cladonia* spp.) as the main components along with a considerable amount of grass.

The area in which the study was made is adjacent to agricultural land and is subject to fires started by land clearing operations. Owing to the lack of natural water supplies and to the nature of the soil, fire suppression is best effected by hand tools and pumper-tankers.

The cutting methods which had been employed were mainly medium to heavy selection cuts and a few clear cuts.

METHOD OF STUDY

Examples of 6 different slash treatments were available in the Sandilands area, and areas representing 4 stages of slash deterioration were located. Duplicate test fire plots were placed within each slash age-class for each type of disposal method, wherever it was possible. Table 1 shows the distribution of plots which were available and on which the conclusion of this study was based. In addition to the plots listed, two control plots were located in a representative uncut jack pine stand.

The sample plots were square, 100 feet to the side. Two single furrows were plowed around the perimeter of each plot as a fireguard and, where slash was particularly heavy, an additional fireguard was plowed approximately 20 feet outside the first. A Manitoba Forest Service fire ranger and five or more men were present at all tests and, when the plots had been burned, hand tools and pack tanks were used to extinguish the fires.

Four-foot stakes were set at 20-foot intervals throughout the plot providing a grid which greatly facilitated the plotting of the fire perimeter as burning progressed. Just before burning, each plot was inspected and a complete plot description was recorded on specially prepared forms. Particular attention was paid to the height of the slash; ground vegetation; kind, amount, and depth of duff; and the thickness of the humus layer. The number of pieces and sizes of the heavier fuels (3 inches or more at the large end) were recorded.

Air temperature and relative humidity were measured with a sling psychrometer, and other weather conditions were noted. The wind velocity at the time of the fire was measured with a portable anemometer and its direction was estimated with the aid of a box compass. The amount of dew which formed the

TABLE 1.—*Distribution of test fire plots according to slash treatment and slash age class*

Slash treatment	Plots burned when slash age class was—			
	1-2 years	3-5 years	6-9 years	10-12 years
	Number	*Number*	*Number*	*Number*
Left as cut (untreated)	2	2	2	1
Piled and left unburned	1	2	2	2
Piled and burned (100 percent)	1	2	2	2
Tops only (stands with clear-boled trees)	1	2	2	0
Lopped and scattered (maximum depth 18 inches)	1	2	2	2
Windrows (1 chain apart, unburned)[1]	0	2	0	0

[1] This treatment dropped from study because of insufficient data.

previous night was measured by the method developed by the Federal Forestry Branch (7) and recorded in the field notes.

Various sizes of branches, duff, and other fuels were sampled and their moisture content determined by laboratory methods.

Immediately after igniting each test fire, an observer and an assistant began plotting the position of the fire perimeter at 1- or 2- minute intervals depending on the rapidity of spread. Observers worked independently on the leeward and windward sides of the starting point and were able to keep accurate records of the fire's progress with the aid of stop watches and guide stakes. Notes were made also on the height of flame, vigour, smouldering, and depth of ash.

When the fire was out, further notes on the severity of the burn were made. Estimates were made of the percentage of the area left unburned as well as the percentages of each type of unburned fuel.

The careful plotting of the fire perimeter at regular intervals gave a very comprehensive picture of the fire's progress and a measure of its rate of spread. The grids were planimetered and the proportionate area burned during each 5-minute interval of the fire's progress was determined.

A numerical hazard index was computed for each test fire, using much the same method as that employed regularly by the Forestry Branch in rating small-scale test fires (5). In calculating this hazard index the factors used and the relative weights given to each were as follows: (1) rate of spread, 30 percent; (2) total area burned, 20; (3) vigour, 20; (4) height of flame, 10; (5) smouldering, 10; (6) depth of ash, 10. These factors, with the exception of vigour and smouldering, can be measured directly with the result that errors owing to personal judgment are kept to a minimum.

Following the described procedure, all test fire plots shown in table 1 were burned during the summer periods of 1949, 1951, and 1952. A fire weather station was set up in the area and the danger index was calculated daily, throughout the periods of the tests, from the Midwest Fire Danger Tables (*1*). All tests were made when this local danger index was in the range 7 to 12; the average for all tests was found to be 9.

Each test fire was given a hazard rating as determined by the six performance factors listed above. An adjustment of one hazard index unit was made to the rated hazard for those tests made on days when the local danger index differed from the mean by two units or more. For example, one plot was burned on a day when the local danger index was 7. To adjust for the lower fire danger conditions on this day, the rated hazard index for that test fire, calculated to be 11, was increased by one unit to 12.

It should be noted here that the local danger index refers to the average fire danger in all fuel types in the area, whereas the rated hazard index is a measure of the fire hazard as indicated by the individual test fires in the fuel concerned.

ANALYSIS OF DATA

Burned slash.—Analysis of test fire behaviour in cut-over areas where slash had been piled and burned indicated that the hazard is substantially lower than in areas where the slash had been left unburned. Further, it was found that, when slash is burned after cutting operations, the fire hazard can be expected either to be similar to that existing before the area was cut or slightly higher because of increased insolation. Other investigators have found that, under full insolation, fuel temperatures approaching 150° F. are not uncommon.

The conclusions drawn here will hold true only if the slash burning operations have been thoroughly carried out, in which case all the slash in the piles will have been destroyed. It is to be expected, however, that in some instances the original duff and litter will be left unburned between the piles.

Of the test plots burned in this group, one was not included in the analysis. The plot description indicates that there was an 85 percent coverage of jack pine duff and litter on the plot as opposed to an average of less than 10 percent on the remaining 6 plots representing this treatment. The depth of litter and humus on that was double the average of the other plots. This was, no doubt, a result of the unusually high density of the residual stand. Observations made on this plot, therefore, were excluded from the analysis on the basis that fuel conditions were not typical.

Figure 1 shows the comparative hazard to be expected with each type of slash treatment studied and with slash age. The curve for piled and burned slash (fig. 1) describes the hazard of burned slash over the years since it was cut. This curve shows that, if slash burning is done thoroughly, the hazard will be almost nonexistent immediately afterward and will increase,

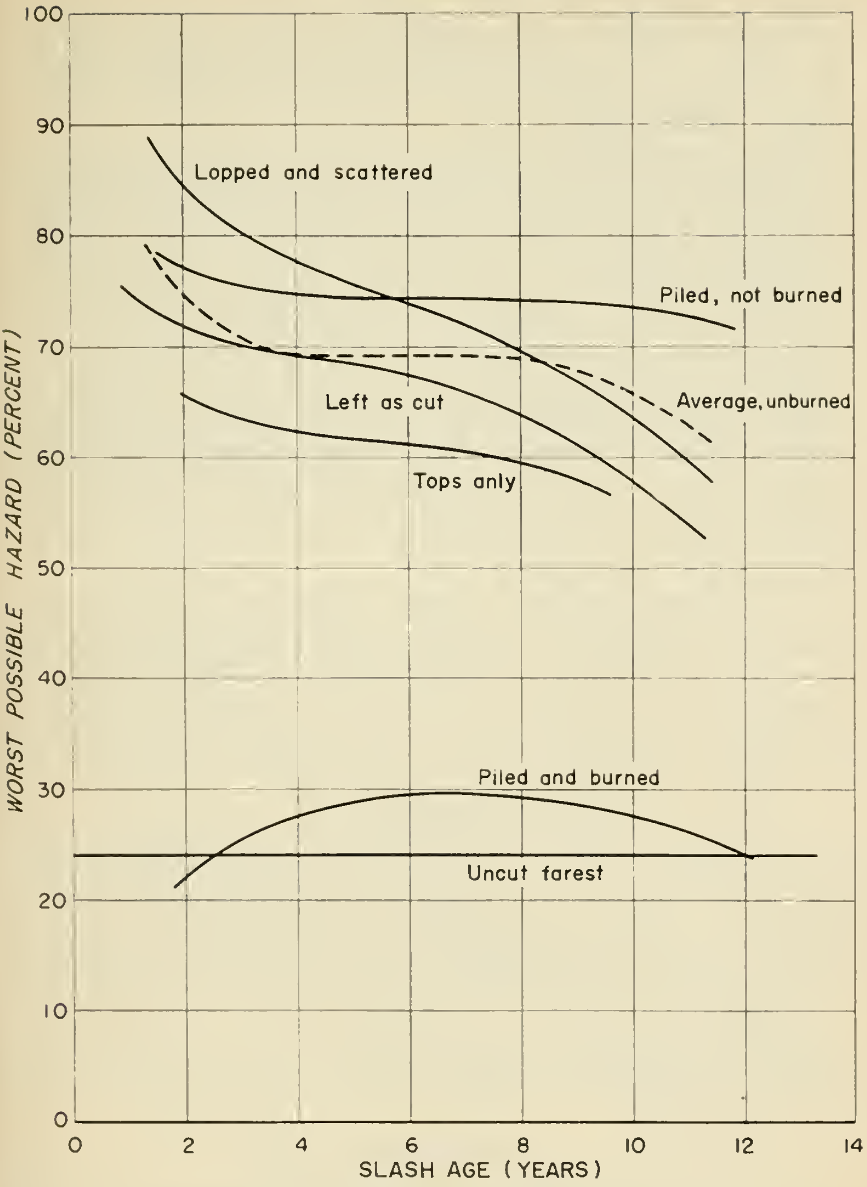

FIGURE 1.—Variation in hazard with age of slash.

within a period influenced by the density of the residual stand and the growth of new vegetation, to a value comparable to that in the uncut stand.

Unburned slash.—The analyses of tests on unburned slash showed that fire hazard will remain comparatively high, regardless of treatment, for at least 10 years after the cut. Figure 1 shows the percent of worst possible[3] hazard to be expected with each disposal method. These methods are listed in decreasing hazard potential at a slash age of approximately 2 years: (1) Lopped and scattered; (2) piled and not burned; (3) left as cut; (4) tops only.

Differences in hazard owing to the use of different treatments of unburned slash, however, were found to be small and of little significance. Of somewhat greater significance is the fact that slash which has been lopped and scattered or left as cut deteriorates more rapidly over the years than that which has been piled and left. Thus the hazard existing in cut-over areas where the slash has been scattered or left strewn about, although initially high, falls off with age at a relatively rapid rate.

On areas where tops only have been left after cutting, the hazard is lower than when other treatments have been employed and the reduction in hazard over the years parallels closely that for piled slash. It should be borne in mind, however, that in the Sandilands area stands are typically open, and this type of slash consists mainly of scattered tops. Where this treatment is used in heavy stands the tops are more or less contiguous and the slash resembles that left as cut.

Of the test fires made in slash which had been piled and left, only 6 of the 7 fires were considered to be truly representative of normal conditions. A changing wind direction during the course of the burning of one plot prevented the fire from burning consistently on any one front. Also, there were more bare patches on this plot than were normally encountered on the remaining six plots. In consequence, observations made on that plot were not included in the analysis.

The average height of the piled slash was 3 feet and when the test fire was in progress, sufficient heat was produced by the burning piles of slash to promote the rapid spread of the fire between the piles. This was normally a distance of 20 feet. Under the piles, all duff and organic matter was completely burned to mineral soil, whereas between piles the burn was light. There was less falling off of hazard with slash age than occurred when the lopped-and-scattered or left-as-cut methods were employed.

In almost all areas of piled slash and tops only, there were sufficient surface fuels to allow the fire to run from pile to pile or from top to top.

CONCLUSIONS

In the region and season in which these tests were made, the burning of jack pine slash, when thoroughly carried out, will reduce the fire hazard to a level comparable to that of the uncut forest and to about one-third of that of unburned slash. Therefore, where hazard reduction is of primary importance, serious consideration should be given to slash burning after cutting operations. This is the only commonly used slash disposal method which is effective in reducing the fire hazard.

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[3] "Worst possible" refers to the highest hazard rating based on the 0 to 16 danger index scale.

The hazard resulting from unburned slash is comparatively high for at least 10 years after it has been cut; about 3 times as great as the hazard of the uncut forest. Some further effects regarding unburned slash were noted in this study: (a) The hazard is highest immediately following the cut when the dead foliage is still clinging to the twigs. (b) The hazard diminishes gradually as the needles dry and fall—that is, until approximately 4 years after the slash has been cut. (c) From this point until the slash is 8 or 9 years old, the hazard decreases slowly as the debris weathers and compacts. (d) After this time the slash has been reduced by weathering and other action to a point where it is overgrown by an increasing abundance of vegetation. With this increased shade, the slash receives less ventilation and solar radiation and, as a result, the rate of moisture loss is reduced, thus further lessening the hazard.

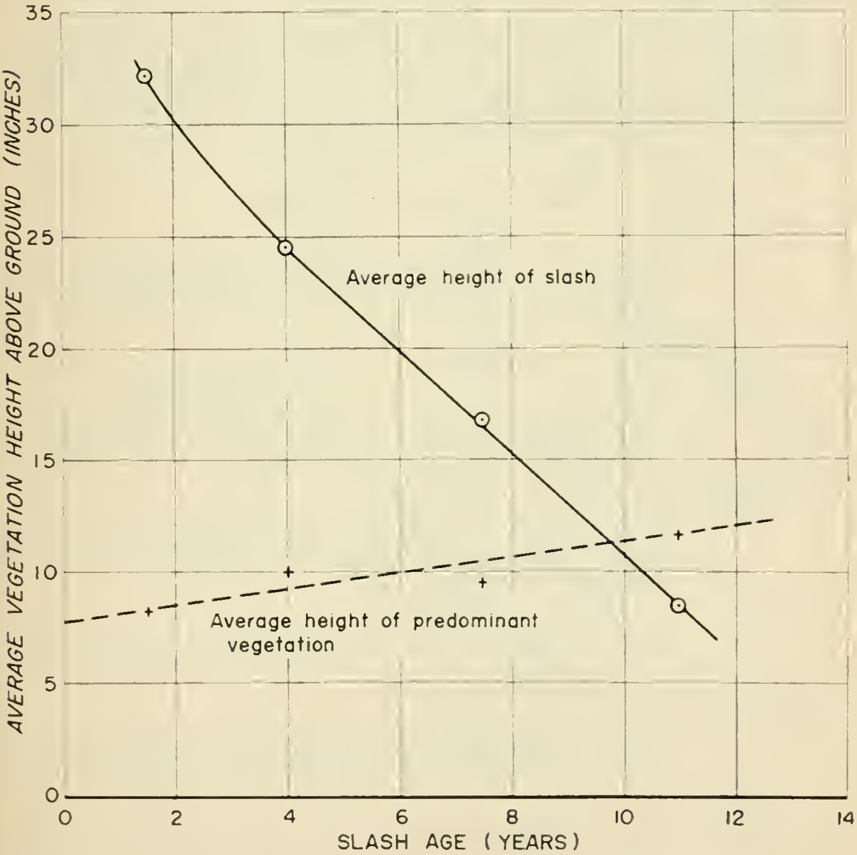

FIGURE 2.—Deterioration of unburned slash with age, and growth of ground vegetation after cut.

An illustration of this process is given in figure 2. The 2 curves show the relationship between average height of slash and height of ground vegetation during the first 12 years following the cut. From this graph it appears that green vegetation begins to overtop the slash 10 years after the cut. Figure 1 shows a general falling-off of fire hazard at approximately this same point. It may be expected that, where environmental conditions differ from those of the area under study, the rate of slash deterioration and vegetative growth may also be different.

The small differences in hazard resulting from the use of the four different treatments of unburned slash are more or less of academic interest only. The choice of one method over another will depend a great deal on the chooser's point of view. For example, it may be felt that the high initial hazard of slash which has been lopped and scattered or left strewn over an area is offset by the relatively rapid rate of hazard decrease which would obtain with increasing slash age. Others may argue that this high initial hazard is too risky to tolerate under any circumstance.

Although Johnson (*4*) found that the poorest regeneration resulted from piling and burning, no slash treatment studied gave a satisfactory stocking of seedlings. Thus, because it results in the lowest hazard, the piling and burning of jack pine slash should be carried out whenever it is economical to do so.

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THE CHRISTMAS EVE PRESCRIBED BURN

ALBERT A. THOMAS[1]
East Gulfcoast Research Center, Southern Forest Experiment Station

It was the morning before Christmas, Santa Claus was loading up and the holly and mistletoe were being hung. Gifts were being wrapped, and the weather was just right for prescribed burning on the Escambia Experimental Forest. The south Alabama woods were damp, the north wind was swaying the tree tops, and the air temperature was near freezing. This was the weather the Escambia foresters had wanted for nearly 2 months. Brown-spot needle disease had invaded several large areas of longleaf reproduction on the forest. The only practical way to save the infected seedlings was to prescribe-burn, and this was the day for the job. Seven years of study and experience went into the planning and application of the Christmas Eve burn (fig. 1).

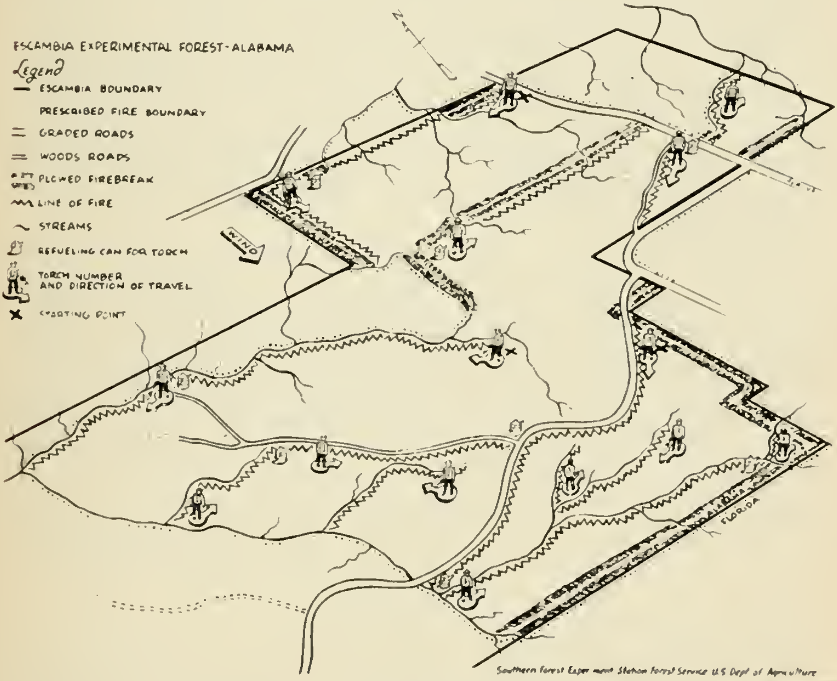

FIGURE 1.—In the Christmas Eve prescribed burn, nearly 1,400 acres of longleaf pine seedlings were rid of brown-spot disease at a cost of 6 cents an acre by 4 men working 4 hours.

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[1] This article first appeared in the March 1956 issue of American Forests and is republished here through courtesy of that periodical.

Prescribed burning is a calculated risk. The risk should be taken only after careful planning and preparation based on a thorough understanding of fire and fire behavior. The guiding principle for prescribed burning on the Escambia is **the burning yardstick.**

The **yardstick** is simple. **Benefits** from the fire must **exceed** all burning **cost plus** fire **damages.** Application is more complex. A five-step procedure is used: **diagnosis, prescription, preparation, treatment,** and **appraisal.** When properly followed this procedure removes most of the gamble, and fire becomes a useful tool in the longleaf forest.

DIAGNOSIS

First, exactly what areas on the forest contained heavy brown-spot infection? What damages could be expected from the use of prescribed fire? To find out, a survey was made. After the first killing frost in early November, the percent of brown-spot infection was estimated on a minimum of 100 longleaf seedlings on each 10- to 40-acre reproduction area.

The survey showed several hundred acres of grass-stage longleaf reproduction infected with brown spot, with the degree of infection ranging from a low of 15 percent to a high of over 35 percent. Past experiments and experience have shown that areas with 25 percent or more infection in November should be prescribe-burned during the coming winter. To prevent reinfection, the area surrounding the seedlings should also be burned where possible.

Longleaf seedlings can generally be burned safely if: (1) they are at least one-half inch in diameter at the root collar; (2) very little root is exposed; and (3) the seedlings are not in active height growth. The survey showed that if fire was applied properly, damage should be confined to a few scattered seedlings 1 to 5 feet high that were already nearly dead from brown spot.

The areas that needed burning were mapped. Then, to plan for control of the fire, information was obtained on the condition of rough, natural fire breaks, roads, and trails.

The diagnosis: Several large areas were dangerously infected. Fire was needed and could be applied without excessive damage.

PRESCRIPTION

Next was to prescribe the fire treatment for each area—the kind of fire and the weather needed.

If the areas had had a heavy rough and lots of draped fuel, a backfire would have been prescribed. Heavy roughs with draped fuel burn very hot, and unnecessary overhead scorch to standing timber would occur if headfire were used. The survey showed, however, that the areas contained a light rough—a small accumulation of pine straw and not much grass. A fast-running headfire would be safe and do a better job than a backfire.

Weather is the most important factor in prescribed burning. Cold weather and plenty of ground moisture are essential. This means burning in winter as soon as possible after 1 inch or more of rainfall. To get a fast-moving headfire, a moderate, cold north wind is needed—north wind because it is usually dependable and steady in south Alabama. To insure that all areas will be covered while ideal weather lasts, fires should be started by 10:00 a. m. and be completely under way by noon.

The prescription: A headfire on a day when ground moisture was plentiful and a moderate, steady, cold north wind was blowing. The fire to be under way before noon and to cover the areas in a few hours.

PREPARATION

Successful burning can only be done after thorough preparations for applying and controlling the fire.

In delineating each area to burn, natural firebreaks such as roads and streams were used wherever possible, to save firebreak contruction. Nearby landowners were contacted. Letting neighbors know what's going on is always good public relations, and on the Christmas Eve Burn permission was needed to burn two areas into natural firebreaks outside the forest boundary. This saved more than one-half mile of firebreak construction, and eliminated two heavily infected areas adjoining the forest.

Since the prescription called for headfire and a north wind, 2 lines about 100 feet apart were plowed and burned on the south, east, and west boundaries to control the fire where natural firebreaks were not available. On the north side of the area only a single plowed line was necessary.

Next, was to be sure a headfire would be under way in all areas by noon of D-day, and that burning would be completed a few hours later. The map showed that one line of fire along the north boundary would have to travel more than a mile. This is too far. Experience has shown that one-half mile is about the maximum for the time allowed in the prescription. Otherwise, the burn may not be completed before weather conditions change. Another east-west firing line was therefore put in. Natural firebreaks could be used to fire the rest of the area.

A total of 9 miles of line had to be fired. One torch man would be able to fire about 3 miles in the allotted 2 hours between 10:00 a. m. and noon. The line was roughly divided into 3-mile sections and assigned to men designated as Torches 1, 2, and 3. Since 1-gallon fire torches hold only enough fuel for about three-fourths of a mile of line, refueling cans would be needed at intervals along the line. A small letter-size map was prepared to show each torch man (1) the line to fire, (2) the direction of travel, (3) locations of refueling cans, and (4) how to fire his part of the line. A crew of 3 torch men and 1 man supervising and patrolling the burning area was required.

By early November everything was ready except the most important item, the weather.

TREATMENT

It was the day before Christmas, Santa Claus was busy with his myriad preparations for his trip that night, but the weather was just what the doctor ordered for prescribed burning. There had been almost 3 inches of rainfall in the past 3 days. Air temperature was down to 29°F. A cold front was overhead and a moderate, steady, north wind was blowing. The Weather Bureau predicted that this condition would last for 10 to 12 hours.

Early morning telephone calls were made ordering the crew to get into their "burning" clothes. The Alabama and Florida forestry departments were notified to expect a big smoke starting at 10 o'clock. Torch fuel was distributed to the planned points along the burning lines. At 9:30 a. m. the crew met on the forest. A small test fire was set and then each torch man was briefed and given his map. At exactly 10 o'clock all three torches started firing. A few minutes after 12 noon all torches were through and well over half of the area was burned. At 2 o'clock over 90 percent of the area was burned. By 3 o'clock the crew, tired but satisfied, was back home helping Santa Claus.

APPRAISAL

What were the benefits? Longleaf experts agree that a heavy infection of brown spot can ruin a stand of seedlings. The established seedlings treated by the Christmas Eve Burn were worth at least $4,000. It is doubtful that half of these would have survived and grown without the prescribed fire. At least $2,000 worth of seedlings were saved.

What was the cost? The whole job, including diagnosis, prescription, preparation, treatment, and appraisal, came to less than $100.

What were the damages? A seedling survey after the fire showed less than 1 percent loss in stocking—a value of not more than $50. Most of the lost seedlings were stunted and heavily infected with brown spot and probably would have died anyway. Their value was more than offset by many fringe benefits, such as hardwood brush control, seedbed preparation, hazard reduction, and a large area burned to prevent reinfection of the reproduction areas.

The **burning yardstick showed** that the **benefits** of several thousand dollars in brown-spot control far **exceeded** the burning **cost plus** the minor **damages** of the fire.

A READY-REFERENCE RADIO DISPATCH BOARD

GEORGE W. DEAN
State Forester, Virginia

The large number of mobile and tower radios now in service with the Virginia Division of Forestry made it necessary to find a simple record system that would expedite the clerk-dispatcher's job of keeping track of the frequent changes in location and activities of men in the field. One district forester devised such a system from a piece of acoustical tile and roofing nails, and with a minimum number of changes the unit was workable statewide.

The ready-reference board is made of ¾-inch plywood 14 inches wide, and it is 14 inches or more in height (fig. 1), depending upon the number of radios in use. Holes are bored on ½-inch centers large enough to accommodate 8-penny, double-headed nails. Since the entire length of nail is not necessary, it is cut

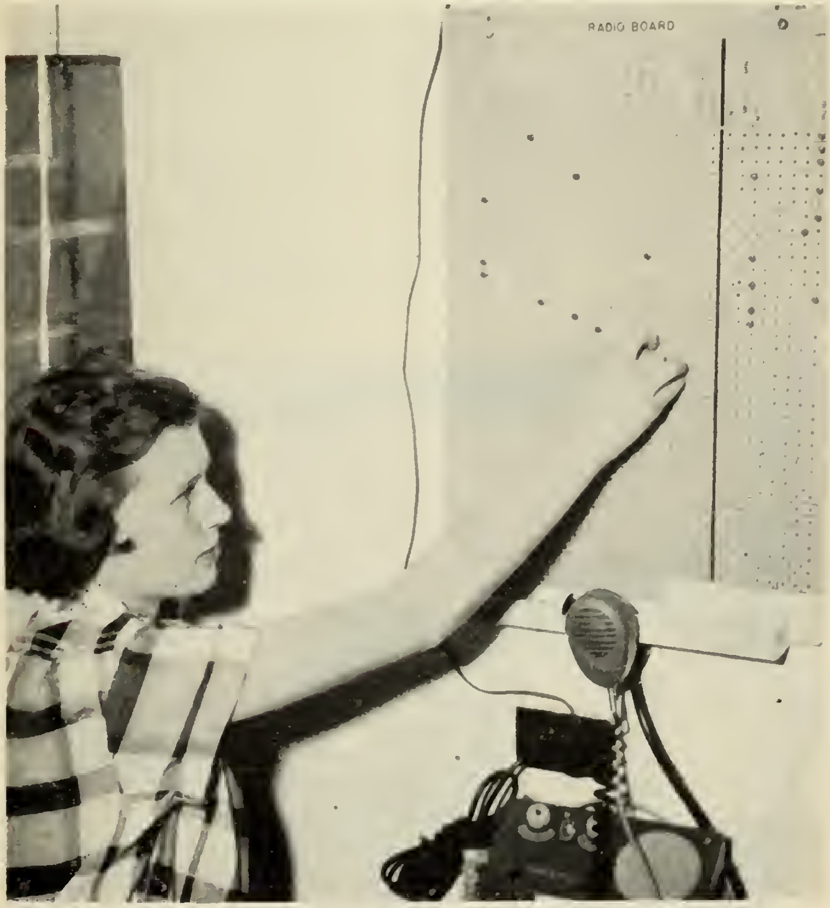

FIGURE 1.—The ready-reference radio dispatch board.

in half. A small, compartment tray, which is screwed to the bottom of the board, serves as a storage bin for the nail pegs. The nail pegs are painted red for off-air, green for on-air, and yellow for special messages. The board's vertical columns are headed by counties in the district and major jobs, and one column is headed "Special message." The column to the extreme left lists the mobile or tower units.

When a unit signs on the air, the clerk places a green nail in the hole opposite the name and under the proper county. If the unit is called to a fire, a green nail is added to the horizontal column under the vertical heading "On fire." Should the unit sign off the air to go in on the fire, the clerk replaces the 3 green nails with red ones. If a special message comes in for the off-air unit, a yellow reminder nail is placed in the special message column. When the unit signs on, the red nails are replaced with green, the special message is given, and the yellow nail is removed.

A large district map—a montage of county maps on which towers are located and provided with azimuth circles and strings—is used to supplement the dispatcher's ready-reference board (fig. 2). This map is covered with clear plastic, the kind used for inexpensive storm windows. As fires spring up, entries are made on the plastic with grease pencil, and a note as to who from the district office is on a fire is also entered. Mistakes or changes are easily erased with a swipe of a cloth. Of course, the ready-reference dispatch board and plastic-covered work map are valuable only if they are kept up-to-date and supplemented with essential, written or otherwise, posted material.

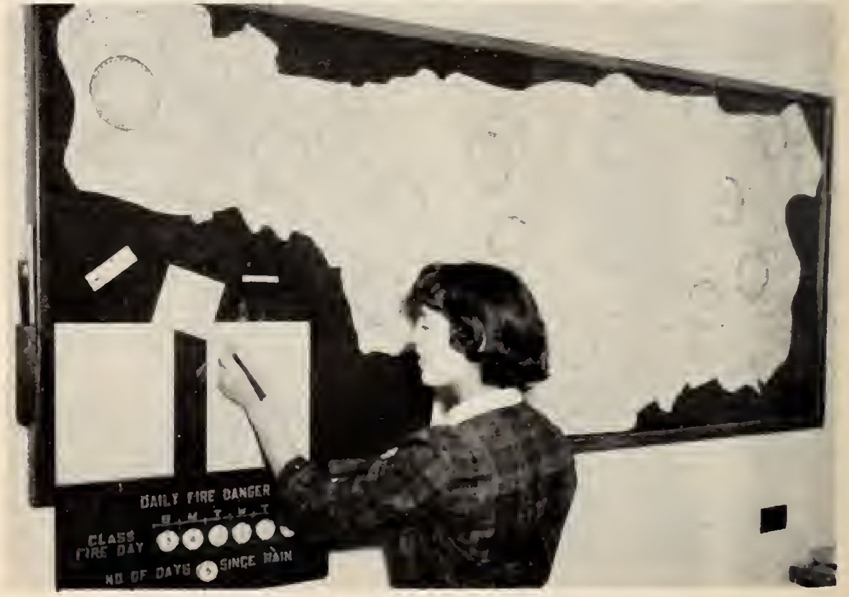

FIGURE 2.—A grease pencil is used to keep information current on this plastic-covered, fire locator map.

OLD-GROWTH CONVERSION ALSO CONVERTS FIRECLIMATE

C. M. COUNTRYMAN
Forester, California Forest and Range Experiment Station[1]

Converting an old-growth forest presents problems that have long challenged foresters, engineers, and economists. Road location, method of cutting, fire control, and slash disposal are all critical jobs. In terms of fire control, the forest manager has been concerned primarily with slash disposal and fire suppression in slash areas. He has frequently observed the great difference in fire behavior between slash and uncut areas, and quite naturally has associated this difference with the obviously different fuel conditions.

Although the general relations between weather factors, fuel moisture, and fire behavior are fairly well known, the importance of these changes following conversion and their combined effect on fire behavior and control is not generally recognized. The term "fireclimate," as used here, designates the environmental conditions of weather and fuel moisture that affect fire behavior. It does not consider fuel created by slash because regardless of what forest managers do with slash, they still have to deal with the new fireclimate. In fact, the changes in wind, temperature, humidity, air structure, and fuel moisture may result in greater changes in fire behavior and size of control job than does the addition of more fuel in the form of slash.

Conversion which opens up the canopy by removal of trees permits freer air movement and more sunlight to reach the ground. The increased solar radiation in turn results in higher temperatures, lower humidity, and lower fuel moisture. The magnitude of these changes can be illustrated by comparing the fireclimate in the open with that in a dense stand. It is the same kind of difference that occurs when a closed, mature stand is clear cut.

In the open, solar radiation impinges directly on the earth's surface. Because both the earth and the air above it are poor conductors, heat is concentrated at the surface and in the layer of air next to it. Ground fuels can thus become superheated. In full sun at midday, it is not uncommon for surface temperatures to reach 165° F. or more.[2] At the same time, air temperatures measured at the standard height of 4½ feet in an instrument shelter may not exceed 85° or 90°. Temperatures in the lower layers of air in the open decrease rapidly with height above the ground. In a typical temperature profile in northern California, for example, the temperature was 135° at the surface and decreased to 77° at 5 feet (fig. 1).

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[1] Maintained at Berkeley, Calif., by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of California. This article was first published in the Society of American Foresters' Meeting Proceedings for 1955.

[2] From unpublished data in files of California Forest and Range Experiment Station. Similar findings were also reported by:

GEIGER, RUDOLF. CLIMATE NEAR THE GROUND. (Trans. 2d German ed.) 482 pp., illus. Cambridge, Mass. 1950.

KITTRIDGE, JOSEPH. FOREST INFLUENCES. 394 pp., illus. New York and London. 1948.

Relative humidity will vary inversely to the temperature of the air as long as the amount of water vapor remains constant. A relative humidity profile, then, can be expected to be the inverse of the temperature profile, and in the open relative humidity near the surface is much lower than that at the standard 4½ feet.

These temperature and humidity relations have an important influence on fuel moisture. In the absence of precipitation, the moisture content of dead fuel decreases as humidity decreases and as temperature increases. Surface fuels can thus be expected to be materially lower in moisture content than fuels a short distance above the ground and exposed to the cooling effect of wind. Measurements of standard half-inch fuel-moisture indicator sticks at the California Forest and Range Experiment Station have shown that the minimum daily moisture content of surface fuels averages only about half that of fuels 10 inches above ground.

A mature, closed stand has a fireclimate strikingly different from that in the open. Here nearly all of the solar radiation is intercepted by the crowns. Some is reflected back to space and the rest is converted to heat and distributed in depth through the crowns. Air within the stand is warmed by contact with the crowns, and the ground fuels are in turn warmed only by contact with the air. The temperature of fuels on the ground thus usually approximates air temperature within the stand.

Temperature profiles in a dense, mixed conifer stand illustrate this process (fig. 2). By 8 o'clock in the morning, air within the crowns had warmed to 68° F. Air temperature near the ground was only 50°. By 10 o'clock temperatures within the crowns had reached 82° and, although the heat had penetrated to lower levels, air near the surface at 77° was still cooler than at any other level. At 2:00 p.m., air temperature within the stand had become virtually uniform at 87°. In the open less than one-half mile away, however, the temperature at the surface of pine litter reached 153° at 2:00 p.m.

Because of the lower temperature and higher humidity, fuels within the closed stand are more moist than those in the open under ordinary weather conditions. Typically, when moisture content is 3 percent in the open, 8 percent can be expected in the stand.

Moisture and temperature differences between open and closed stands have a great effect on both the inception and the behavior of fire. For example, fine fuel at 8-percent moisture content will require nearly one-third more heat for ignition than will the same fuel at 3-percent moisture content. Thus, firebrands that do not contain enough heat to start a fire in a closed stand may readily start one in the open.

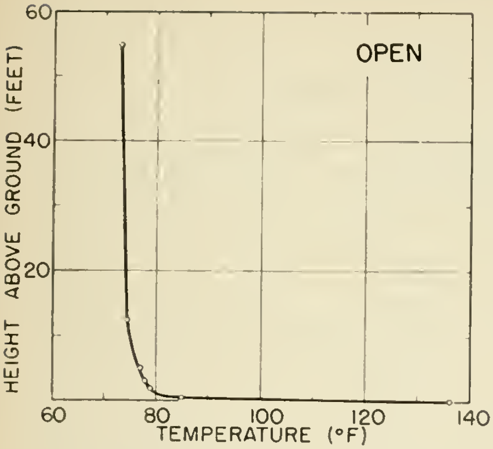

FIGURE 1.—Typical temperature profile over bare ground in the open. (Data taken at 12 a.m., Sept. 16, 1943, Shasta Experimental Forest.)

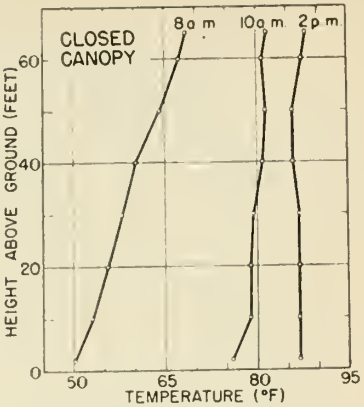

FIGURE 2.—Temperature profiles in a dense, mixed conifer stand in northern California showing the progressive downward transfer of heat into the stand from the crowns. (Data taken Sept. 22, 1943.)

Fires starting in the open also burn more intensely and build up to conflagration proportions more quickly since less of the heat produced by the fire is used in evaporating water from the drier fuels. Strong convection columns that can carry burning material aloft develop rapidly; these columns and the relative ease of ignition in the open are largely responsible for one of the major fire control problems in clear-cut slash areas—that of spread of fire by spotting.

Another very important difference between fireclimate in a closed stand and fireclimate in the open is in air movement. In general, wind direction and velocity 2,000 feet or more above the surface are the result of widespread pressure differences and general weather conditions. In the layer of air below 2,000 feet, surface friction and local landscape features have an increasingly important effect on air movement. Consequently, over an extensive closed stand wind velocity decreases only slightly above the crowns. Within the stand, however, air movement is much restricted, seldom exceeding 3 or 4 m. p. h. even with velocities of 25 to 30 m. p. h. above the canopy or in the open (fig. 3).[3]

Since the rate of forward spread of fire is largely dependent upon wind velocity, a much faster rate can be expected in the open, at least in the initial stages of the fire. For example, under

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[3] KITTREDGE, JOSEPH. FOREST INFLUENCES. 394 pp., illus. New York and London. 1948.

FONS, W. L. INFLUENCE OF FOREST COVER ON WIND VELOCITY. Jour. Forestry 38: 481-487, illus. 1940.

GISBORNE, H. T. HOW THE WIND BLOWS IN THE FOREST OF NORTHERN IDAHO. U. S. Forest Serv., North. Rocky Mt. Forest and Range Expt. Sta. 12 pp., illus. 1941. [Processed.]

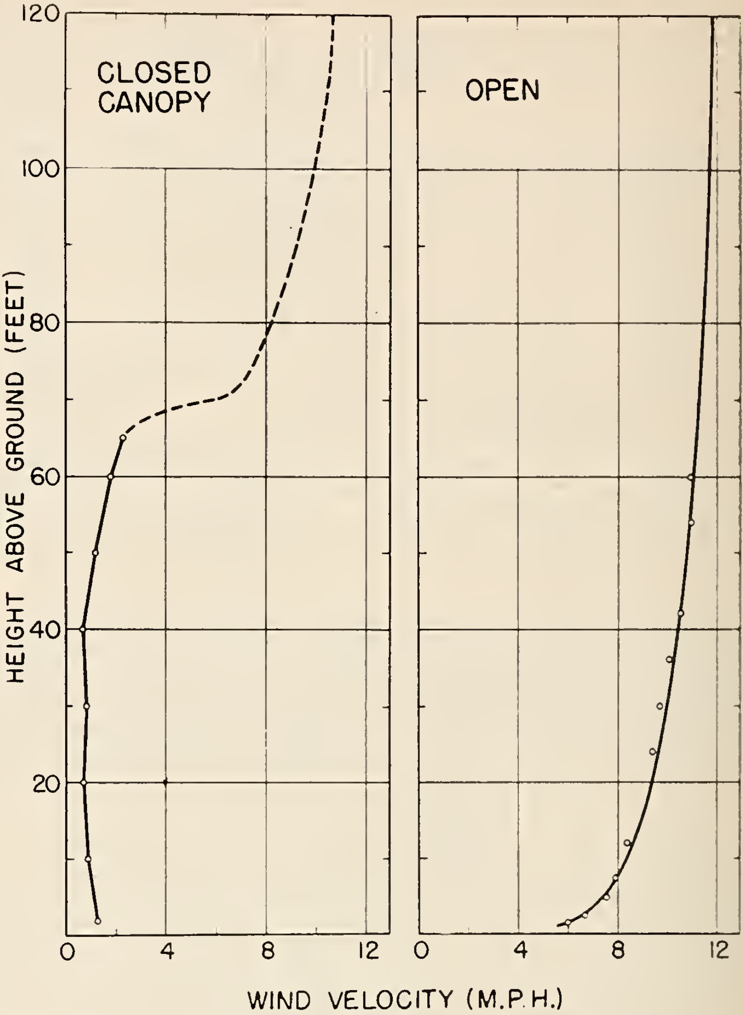

FIGURE 3.—*Left,* Typical daytime wind profile in and over dense conifer stand. *Right,* Typical daytime wind profile over level ground in the open.

moderate conditions of fuel moisture and temperature, a wind velocity of 25 m. p. h. will result in a rate of spread more than 5 times as great in the open as in a closed stand because of wind differences alone.

Clear cutting, then, can change fireclimate so that fires start more easily, spread faster, and burn hotter. The effect of these changes on the fire control problem is extremely important. When a standard fire weather station in the open indicates a temperature of 85° F., fuel moisture of 4 percent, and a wind velocity of 15 m. p. h.—not unusual burning conditions in the West—a fire starting on a moderate slope will spread 4.5 times as fast in the open as in a closed stand. The size of the suppression job, however, increases even more drastically.

Greater rate of spread and intensity of burning require control lines farther from the actual fire, increasing the length of fireline. Line width also must be increased to contain the hotter fire. Less production per man and delays in getting additional crews complicate the control problem on a fast-moving fire. It has been estimated that the size of the suppression job increases nearly as the square of the rate of forward spread. Thus, fire in the open will require 20 times more suppression effort. In other words, for each man required to control a surface fire in a mature stand burning under these conditions, 20 men will be required if the area is clear cut.

Methods other than clear cutting, of course, may bring a less drastic change in fireclimate. Nevertheless, the change resulting from partial cutting can have important effects on fire. The moderating effect that a dense stand has on the fireclimate usually results in slow-burning fires. Ordinarily, in dense timber only a few days a year have the extreme burning conditions under which surface fires produce heat rapidly enough to carry the fire into the crowns. Partial cutting can increase the severity of the fireclimate enough to materially increase the number of days when disastrous crown fires can occur.

Forest management is impossible without adequate fire control, and it is axiomatic that fire control planning is a vital part of timberland management. It is important to recognize that besides creating additional fire hazard in the form of slash, stand conversion can alter the fireclimate for many years. Therefore, the effect of silvicultural practices on fireclimate must be given major consideration in the management plan for the forest. Protection must be adequate to compensate for the changes in fireclimate as well as for slash. This is the only way to insure that we convert our old-growth forests to managed stands and not to wasteland.

ICE HYDRANT PROVIDES EMERGENCY WINTER WATER SUPPLY FOR FIRE FIGHTERS

Federal Civil Defense Administration[1]

Glen Miller, Civil Defense Fire Chief, Moose Pass, Alaska, has developed an ice hydrant, first of its kind, that can provide an emergency water supply for fire-fighting forces in those communities located near lakes and streams which are frozen over during winter months.

Miller's idea involves the use of diesel oil to keep a water hole open in the ice of a lake or stream. A 55-gallon oil drum, with both ends removed and supported by timbers, is inserted into a water hole (fig. 1). The drum is braced so that approximately 12 inches remains above the surface of the ice. Miller calculated that 30 gallons of diesel oil in the drum would be necessary to extend the oil level through 18 inches of ice to the water level.

After two successful tests of the device at Lake Hood, Anchorage Civil Defense officials reported these details of the project, together with their recommendations:

1. In areas faced with excessive icing, ice-hydrant oil containers should consist of two 55-gallon drums welded together for a total length of 72 inches. Any sturdily constructed steel or iron cylinder, such as 24-inch culvert pipe, will serve as well as 55-gallon drums.

2. By increasing the height of the oil column in the cylinder to 24 or 30 inches above the upper ice surface, sufficient oil pressure would be developed to reduce the degree of freezing below the oil level.

3. Twenty-foot lengths of 4½-inch hard suction hose are more adaptable for use in an ice hydrant than 10-foot sections of 4-inch hose. In pumping through an ice hydrant, the suction hose should be connected to the pump before passage through the oil cylinder into the water, in order to cut down or eliminate the intake of oil.

4. The degree of bend required to extend hard suction hose from a pumper through the ice hydrant indicates that an oil cylinder with a diameter of less than 24 inches would be impractical if not unworkable.

5. Hard suction hose to be inserted in the ice hydrant should be wrapped with masking tape as protection against oil damage. In the brief test, however, 6 feet of the exterior of the hose was covered with diesel oil, with no evidence of damage. Methyl alcohol was used to remove all trace of the oil after the test.

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[1] This slightly shortened article appeared originally in March 1956 as Fed. Civ. Defense Tech. Serv. (Fire Off.) Leaf. 289.

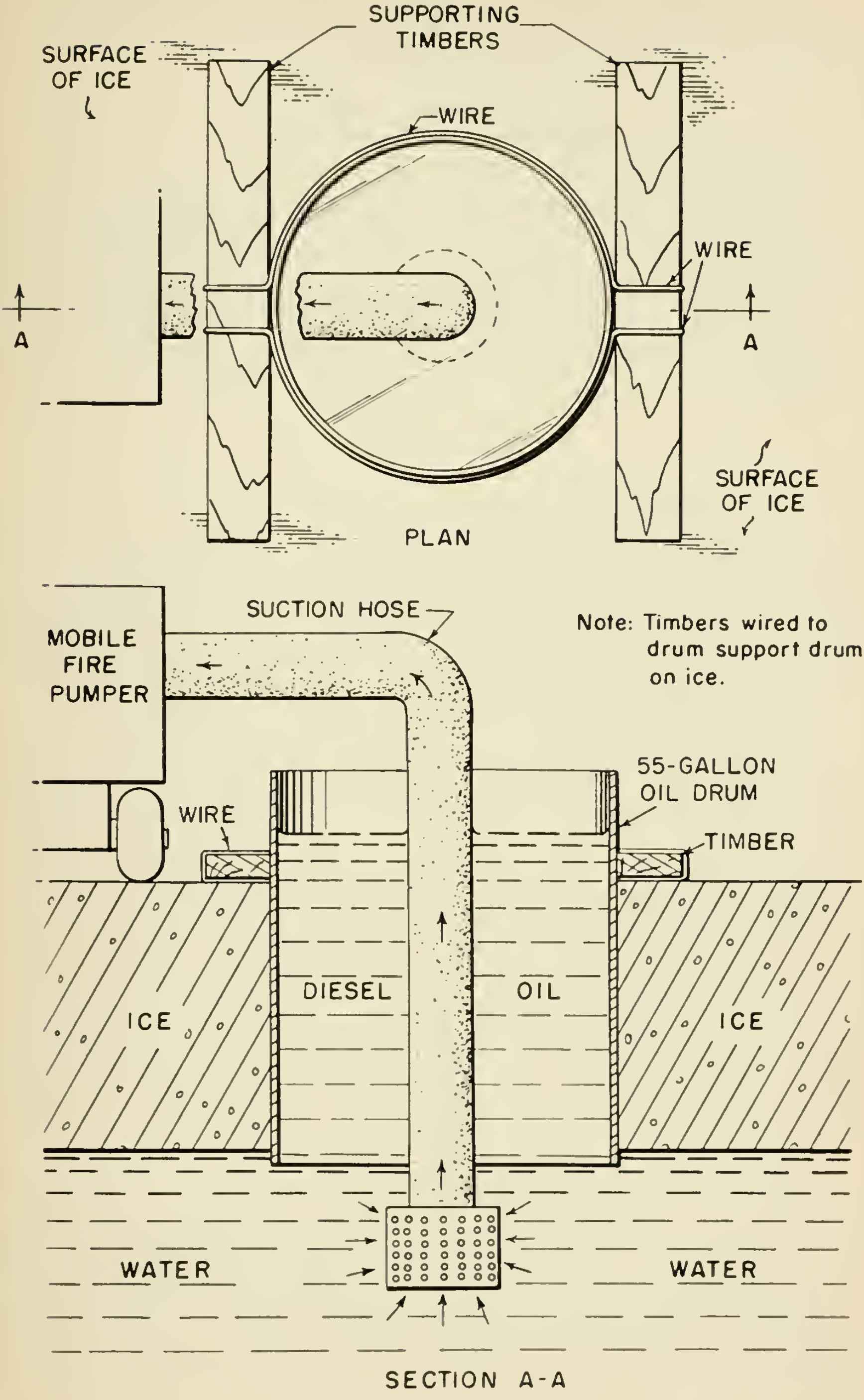

FIGURE 1.—Ice hydrant.

6. A tight-fitting, well-insulated cover for the ice hydrant will cut down the formation of ice and prevent humans and animals from falling into the oil-filled hole.

7. A 6-foot long ice chisel or bar and an 8- to 12-inch mesh strainer should be stationed near each hydrant for clearing and removing ice from the cylinder.

8. Until an oil-tight cover is developed for attachment to the intake end of the hard suction hose, the initial discharge of water should not be played on a fire. Such oil as enters the hose is cleared in a matter of seconds after pumping has started.

9. Before a thaw, the oil in the ice hydrant should be removed or burned to avoid water contamination or harm to fish or wildlife.

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The IBM and Forest-Fire-Report Computation

The State of Louisiana has 7,000 to 10,000 wildfires each year, most of which occur during a 6-month period. Until recently, the computation and recording of statistics from these fires required the services of a full-time clerical helper. During the height of the fire season the reports were so abundant that statistics could not be kept current; and during the green season there was time to spare.

The clerical position was not particularly interesting because of its routine nature, and this fact created a personnel turnover; with each turnover the system bogged down. The major weakness in our system, however, was borne out vividly after the 1952 emergency fire season. On top of the Gargantuan job of compiling the fire statistics came requests for detailed comparisons of fire records. It was next to impossible to meet this request.

The problem seemed to have no solution—i.e., until we decided to explore the International Business Machines System. Under this system the greater part of the information recorded on each fire report is punched into a card: Description of acreage burn (natural forest acres, planted or open); date of fire; district, parish or county; cause; time factors; equipment; manhours; forest types and fire intensity (Class Fire Day); burning and build-up index; and damage.

The greatest single time and cost factor in this system involves punching the information into the cards. After that, summaries are mechanical. The cost per individual fire report is 18 cents as opposed to about 28 cents when computed by clerical help. In addition to this advantage, greater accuracy results, current information is available, and less storage space is required. Very soon we shall be in a position to furnish statistical comparisons in 2 days' time—a feat that used to take months or was impossible.—LAMBERT H. ROMERO, *Staff Forester, Louisiana Forestry Commission.*

EFFECT OF FIRELINE MECHANIZATION ON AREA OF BURNS

DIVISION OF FIRE CONTROL
Region 8, U. S. Forest Service

A question frequently arises as to how great a reduction in fire losses can be expected from the use of powered fireline-building equipment in the place of handtools. Past studies have indicated that the reward of mechanization is a reduction in suppression costs and in size of burns and resultant damage. However, findings from those studies were subject to qualifications imposed by the limited number of years of mechanization and extent of areas available for comparative study. Region 8 has now completed 10 years during which a significant number of ranger districts were sufficiently supplied with mechanized fireline units to yield sound conclusions.

An analysis has been made of the records of 22 Coastal Plain and 8 upland mechanized ranger districts to determine the number of fires and national-forest acres burned during the past 15 years. The data were assembled by 5-year-period totals, with the fast-fire-spread Coastal Plain areas separate from the upland districts. Although ranger districts were divided and names and boundaries changed during the analysis period, each 5-year statistical period still covers the same protection areas.

The period 1941-45 reflects results of handtool fire fighting: 1½ years of Civilian Conservation Corps labor and 3½ years of hired crews. However, there were some tractor-plow units at work throughout that period, with increased number in 1945, which no doubt reduced the amount of timber that otherwise would have burned.

During 1946-50 the design and quality of mechanized units were improved and new units were acquired and assigned in numbers that gave the ranger districts an attack strength more nearly equal to their suppression problems. However, some of of the fires during peak loads still had to be fought by hand.

In the period 1951-55 only a few additional mechanical units were acquired. Suppression action and results, however, were better because of past experiences that developed clearer tactical concepts of mechanized attack and increased the skill of the operators and supporting crews.

The base data employed in this analysis is massive, involving a total of 24,344 Coastal Plain and upland fires on 5,383,138 acres, and covering the variety of forest conditions and fire problems found in the approximately 1,000 miles from South Carolina to Texas. Because of the number of fires analyzed and their geographic distribution, and the spread of time involved, such effects as human error or seasonal variations are blended. The resultant figures also absorb the effects of the steady increase in burning intensity and resistance to control occasioned by buildups in ground fuels and timber-stand densities that developed along with reductions in burned area.

The most significant revelation in table 1 is found in the end-result figures that show a saving of two-thirds of the average acreage lost per fire when mechanized suppression methods are used. On the basis of present-day fire occurrence and with continuation of handtool methods on these districts, assuming no increase in suppression difficulties, 44,000 acres would burn annually rather than 14,000 acres. The calculation of average fire damage shows an annual saving in excess of $500,000. This indicated annual saving in damage alone is greater than the total investment in fireline equipment for the ranger districts involved. They now have 91 tractor-plow units, a concentration of 1 unit to 59,000 protected acres, with an average annual occurrence of 25.2 fires per 100,000 acres.

TABLE 1.—*Effects of fireline mechanization on average loss per fire on 22 Coastal Plain*[1] *and 8 upland*[2] *national-forest ranger districts, 1941-55*

Suppression method	Coastal Plain			Upland		
	Fires	Total burn	Average loss per fire	Fires	Total burn	Average loss per fire
	Number	*Acres*	*Acres*	*Number*	*Acres*	*Acres*
Handtool:						
1941-45	7,183	279,775	38.95	2,078	21,100	10.15
Mechanized:						
1946-50	6,573	96,925	14.74	1,714	8,914	5.2
1951-55	5,132	63,050	12.28	1,664	7,817	4.7

[1] Alabama, Florida, Louisiana, South Carolina, Mississippi, Texas.
[2] Mississippi, Alabama, Georgia, South Carolina.

SODIUM CALCIUM BORATE AS A FIRE RETARDANT:

A Progress Report

HARRY R. MILLER

Forester, California Forest and Range Experiment Station[1]

[Because of its high abrasive and soil-sterilant qualities, the use of sodium calcium borate is limited to the California experiment until further experience is obtained and fire apparatus specifically designed to handle the mixture is made available. By agreement with the manufacturer, sodium calcium borate is supplied only through the California Forest and Range Experiment Station until the experiments have been completed.—Ed.]

Tests conducted in 1955 suggest that chemical fire retardants can open up a new era in forest fire control. Retardants were successfully used to hold the flanks and rear and cooler parts of the head of wildfires in brush and grass and for rapid construction of backfire lines. Aerial delivery of retardants was shown to be feasible.[2]

Several chemicals had shown promise for wild land fire control during Operation Firestop in 1954. Since only plot tests were used in Firestop, however, the practicability of using chemical retardants on going wildfires needed testing before research to develop the most effective methods and formulations was undertaken. Consequently, a cooperative research study was established to meet the following objectives:

1. To test the feasibility of using chemicals in wild land fire control under full-scale field conditions.
2. To gain information on the problems involved in the use of chemicals on fires.

Cooperators with the California Forest and Range Experiment Station in the field program were the California Division of Forestry, Los Angeles County Fire Department, and the Pacific Coast Borax Company.

TEST PROCEDURE

Sodium calcium borate was the retardant selected for use in this study. This substance is representative of the group of chemicals which retard firespread by their insulating qualities as well as chemical action. Sodium calcium borate is an ore mined and processed on the West Coast. The chemical is nontoxic to human beings and livestock. It is slightly corrosive to zinc and brass but is not corrosive to iron. Such borate compounds may be used as soil sterilants and herbicides when applied at the rate of 10 to 15 pounds per 100 square feet of surface area (fig. 1). Less

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[1] Maintained at Berkeley, Calif., by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of California.

This article first appeared in a slightly different form as U. S. Forest Serv. Calif. Forest and Range Expt. Sta. Forest Res. Note 105, CHEMICAL and Range Expt. Sta. Forest Res. Note 99, 12 pp., illus. 1955. [Processed.]

[2] ELY, JOSEPH B., AND JENSEN, ARTHUR W. AIR DELIVERY OF WATER HELPS CONTROL BRUSH AND GRASS FIRES. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. Forest Res. Note 99, 12 pp., illus. 1955. [Processed.]

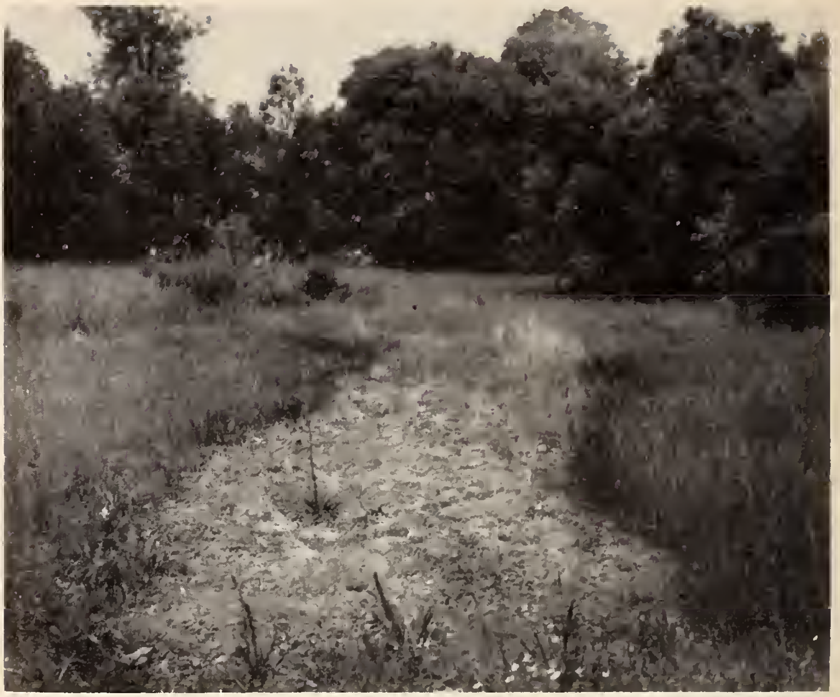

FIGURE 1.—An area in Amador County, Calif., 10 months after borate had been applied on a test fire at about 15 pounds per 100 square feet. Application inhibited the germination and growth of all annual grasses in the area treated.

than 2 percent of the material is soluble in water; but when finely ground, it can easily be put into a stable suspension at concentrations up to 8 pounds per gallon of water. Besides a high melting point (1,000° C.), the chemical has other properties particularly desirable in a fire retardant to be applied in spray form. It covers well and adheres well to vegetation.

Standard pumper tankers equipped with centrifugal pumps[3] were modified slightly for these field tests. Openings were made in the top plate of the tank so that dry chemical could be poured easily into the water. Agitation for mixing was obtained by leading a bypass pipe from the pump back to the bottom of the tank.

Before each unit was put into operation, its crew was oriented by personnel from the Pacific Coast Borax Company and the experiment station. Proper mixing and possible methods of application were demonstrated. One member of each tank-truck crew was trained to observe the effect of the chemical on fire and to record the information necessary for evaluating results. Crew foremen designated the method of application on each fire. In order to encourage exploration of different uses and techniques, precise procedures or limitations were not established.

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[3] A small, positive displacement pump under test at the Arcadia Equipment Development Center was seriously damaged by the chemical within 10 minutes.

USE AND RESULTS

In spite of the severe 1955 fire season in California, the test units had only a few opportunities to use chemicals. Nevertheless, results were encouraging.

Wild land fires.—Approximately 5,800 feet of firelines, 4 to 6 feet wide, were pretreated (sprayed in advance of the fire) through grass and light to medium-heavy brush to hold the flanks, rear, and head of fires. The fuel was coated with retardant applied as a fine spray at about 3 gallons per 100 square feet, 5 to 30 minutes before it was reached by fire. This chemical line held except for one small section in grass which burned through at the head of a fire.

According to the associate State ranger in charge, the sodium calcium borate assured control of one flank of the 700-acre Camanche Fire that occurred in Calaveras County in September 1955. The fire boss reported that attempts to backfire from a plain waterline were ineffective, and the tanker crew was forced to abandon the attack. About 2,000 feet of chemical line was then prepared along the east side of the fire and fired from successfully.

Controlled burning.—On a moderate slope, 1,600 feet of line 6 to 8 feet wide was treated through grass and light to medium-heavy brush across the head and on the flanks of the fire. The retardant was applied to the fuel as a fine spray at 3.5 gallons per 100 square feet and allowed to dry 3 to 4 hours before the area was fired. The flanks and cooler parts of the fire head were contained by the chemical line. Hot parts of the fire head burned through the line. Experienced observers reported that these same fire heads probably would have swept across cleared firebreaks of the same width.

Spot fires.—A serious source of spot fires in the oak-woodland type was reduced by pretreating scrub oaks inside the fireline. Surface fuels at the base of trees and about 4 feet of the lower part of each crown were sprayed with retardant. The chemically pretreated scrub oak did not ignite and "crown-out," whereas untreated trees burned readily.

Backfiring lines.—The use of a chemical retardant for rapid construction of backfiring lines showed excellent possibilities as a fire tool. Crews moved through light brush and grass at a fast walk, applying retardant on 2- to 4-foot strips. Backfiring was successfully done from these lines 0 to 20 minutes later.

Direct attack.—The chemical was applied as a spray directly on burning light brush and grass fuels along 1,500 feet of fire edge. It appeared to be as effective as water in cooling down and extinguishing the fire. Fewer reignitions were observed than would normally occur when water was used under the same conditions.

Equipment.—A Bean type spray gun proved most suitable for applying the chemical directly to burning fuels. An overshot or basement applicator (in common use by city fire departments) equipped with a shutoff valve and a spray tip was used for pretreatment of fuels. This applicator, 5 feet long with a 30 degree bend about 10 inches from the tip, was excellent for spraying tall or dense brush.

Measurements on a Berkeley 4-stage centrifugal pump used in Amador County showed wear of .015 to .022 inch between the suction eye and wear ring of each stage, and .028 inch in the tail shaft bearing at the discharge end of the pump. Although this amount of abrasion is large compared to that experienced with clear water, it is about the same as normally occurs with dirty irrigation water. Much of the wear probably resulted from the mixing process, which required the chemical to pass through the pump several times.

Penetration and coverage of fuels were best when the sodium calcium borate was applied at a concentration of 5 pounds per gallon of water, through a spray nozzle of 4.5 to 7.0 gallons per minute capacity, and at a pressure of about 150 pounds per square inch.

CONCLUSIONS AND RECOMMENDATIONS

1. Chemical fire retardants have a significant advantage over water for control of brush and grass fires. Chemicals can be used effectively to stop fires or materially reduce spread whenever heat output is not too great. This means that chemicals can be used to control small spot fires and the flanks, rear, and weak heads of large fires. The chief superiority of chemical attack over water lies in the long time that chemicals remain effective. This lasting quality of retardants permits treating fuel well in advance of the fire. For example, the chemical can be sprayed in a straight line ahead of a rough irregular fire edge, whereas water has to be applied directly to the fire edge.

2. Chemical retardants appear to have much broader uses in forest fire control than could be tested in 1955. Among potential uses which may be of major importance are aid in slash-fire control, widening existing firebreaks, and building fireline in rocky soil where bulldozers cannot be used. More intensive field testing under a wider variety of fuel and burning conditions is needed to establish the limits of potential chemical use.

3. Preliminary indications are that aerial application of fire retardants is feasible. Further development of techniques and equipment is needed to utilize the full potential of chemicals in this method of fire attack.

4. Equipment and methods to simplify and speed the mixing of chemicals with water are needed. If mixing could be done at the pump, then chemicals could be carried dry in hoppers and either water or chemical attack could be selected at will. Mixing at this point should also eliminate most abrasion in the pump.

5. In conjunction with field tests, laboratory studies are needed to determine the best formulations, concentrations, and application rates for various fire situations.

PREVENTIVE MAINTENANCE PAYS OFF

ROBERT F. WELLS
Missouri Conservation Commission

Preventive maintenance of vehicles and heavy equipment has paid dividends for the State of Missouri. Before our maintenance program was organized, we were troubled with constant breakdowns of equipment during critical periods, and also by costly repair bills. As the number of vehicles in operation by the department increased, the problem became acute.

Our program is organized with a Central Repair Shop to supervise the maintenance and repair of all the equipment. All new vehicles are received there, furnished with special equipment and sent on to the field. Major overhauls are also handled there. In addition, each Fire Protection District is equipped with a small shop where repairs and maintenance designated for the district level are undertaken. The work done at the district level largely accounts for the fine care our vehicles now receive.

Our entire program is geared in the operator's direction. Once each month an inspection is made at the district level to check the condition of each piece of equipment and determine what repairs are required. Constant pressure is exerted on the operators to see that they keep their equipment in the very best of condition. These inspections also serve as the means of keeping the operators informed on their progress. In addition, men from the Central Repair Shop visit the districts once a year and inspect all equipment. This inspection permits us to evaluate the effectiveness of the work of the district equipment men and the operators. It also furnishes information to be used in planning for the replacement of various units.

In order to compare the care given the equipment by the various districts, and as a means of judging the work, a system of numerical grading is used by men from the Central shop on their annual inspection. The maximum attainable grade is 100, and 75 is the lowest acceptable minimum. Grading takes into account the normal wear and tear on equipment and places emphasis on items that should be handled by the operator or district men. Districts are advised of the results of the inspection, and the relative standing of the various districts is given. The grade assigned to each piece of equipment is also available if desired.

The first year that numerical values were used, we had an average annual rating of 76 on a total of 110 units. Four years later we had an average rating of 93 on a total of 170 units. This upswing in average rating is a good indication of the effectiveness of our program of preventive maintenance. We have long since eliminated the problem of breakdowns during critical periods and the costly repairs that plagued us. Also, our operators have a pride in the appearance and condition of their vehicles that was not evident before the program was put into effect.

A secondary and perhaps more important result of the program has been the competitive effort between districts. District foresters and district-level maintenance men have striven to bring their districts's average rating up to or above that of other districts. Since one or two low ratings on a district lowers its average, more emphasis is placed on proper use of equipment to prevent unnecessary damage. The poor driver or one who fails to properly maintain his vehicle is considered an administrative problem and steps are taken to remedy the situation.

Another important result of the preventive maintenance program is that our trade-in vehicles require much less repair prior to resale than most trade-ins; dealers have therefore increased their allowances for our old vehicles. In many cases dealers do not even look at the units we trade in. The average trade-in allowance has increased about $100 since our preventive-maintenance program was initiated.

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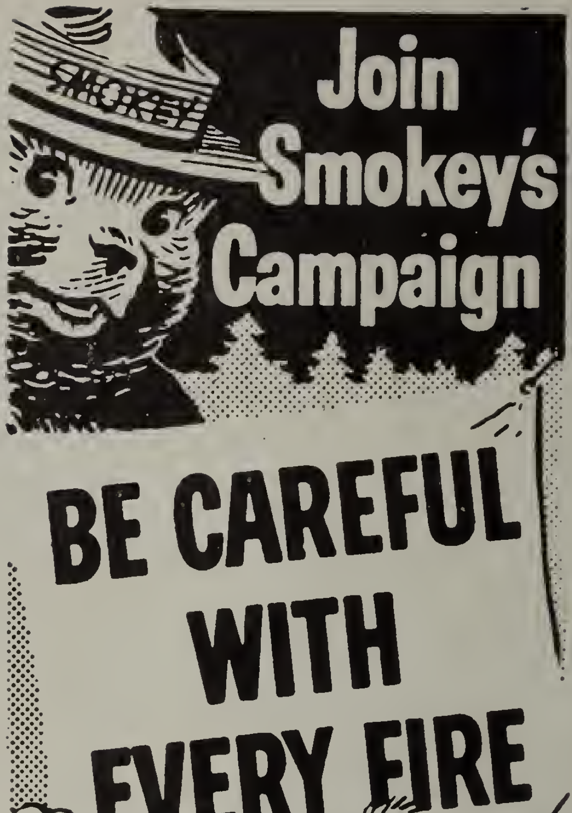

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PREVENT FOREST FIRES!

VOL. 17 JULY 1956 No. 3

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FIRE CONTROL NOTES

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TO THE TECHNIQUE OF
FOREST FIRE CONTROL

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FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE

FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and techniques may be communicated to and from every worker in the field of forest fire control.

Volume 17 Number 3

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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FIRE EFFECTS IN SOUTHERN HARDWOODS

E. Richard Toole and J. S. McKnight[1]

Much of the bottom-land hardwood forest in the Mississippi Delta has burned repeatedly during occasional severe droughts that create extreme fire hazards. The efforts of forestry agencies are reducing the acreage burned. Even so, every person interested in forestry should become familiar with fire damage in this hardwood type. A single fire in a bottom-land stand can completely undo 20 or 30 years of careful management.

The Sturdivant Fire

In November 1952, a fire swept over a tract in the Yazoo-Mississippi Delta. It might have been just another fire, except that it happened to burn in a stand where the Southern Forest Experiment Station had laid out an experiment to measure the growth of well-managed hardwoods. The fire knocked out the growth study, but it led, directly and indirectly, to improved knowledge about the effects of fire, and to suggestions for handling damaged timber.

The fire began early one morning and was not brought under control until early the next morning, by which time it had burned nearly 1,200 acres. As with most large blazes, it was hotter on some areas than on others, and hence caused varying degrees of damage to the timber. From all appearances, though, the damage on the 70-acre experimental area was typical of that over the entire tract.

At the time they burned, these 70 acres were beginning to show the benefits of an improvement cut made 5 years before. The main stand consisted of about 111 trees per acre that ranged in diameter from 6 to 26 inches. Three-fourths of these trees were vigorous and clean boled, likely to produce high-quality wood rapidly. In addition, a generous stand of seedlings and saplings was growing thriftily in openings where mature or low-grade trees had been logged or used for firewood.

The fire virtually wiped out this promising young growth. All seedlings and saplings up to one inch in diameter were killed outright. Trees between 1 and 2 inches in diameter did not fare much better: two-thirds of them were killed and most of the rest were damaged. Among trees between 3 and 5 inches in diameter, mortality was 35 percent.

But the worst damage, at least in terms of immediate financial loss, was to larger trees. Where the fire ran with the wind (head fire), or where logging slash from the improvement cut increased the fuel supply, 33 percent of the trees larger than 6 inches in diameter were killed outright. Of the larger trees that had been classed before the fire as having exceptional promise, 9 out of 10 were killed or damaged severely.

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[1] Delta Research Center of the Southern Forest Experiment Station, Stoneville, Miss., in cooperation with the Mississippi Agricultural Experiment Station and the Southern Hardwood Forest Research Group. The Southern Forest Experiment Station is a part of the Forest Service, U. S. Department of Agriculture.

Where the fire burned across or against the wind (flank or backing fires), or where there was no slash, damage was somewhat less. Even where the flames were least hot, however, 20 percent of the high-grade trees were either killed or damaged so badly that it was no longer a paying proposition to keep them in the stand.

Of course, there will be new growth to replace the loss in the seedling sizes. One year after the fire, over 3,000 sprouts or seedlings per acre were found. Nevertheless, the fire set the seedling and sapling stand back at least 5 years, and it will take 60 or 70 years to replace the larger high-quality stems that were killed or damaged.

Damage to Individual Trees

Trees that are not killed by fire may be severely damaged that they have little, if any, value. The bark on at least one side is usually burned and charred; at first glance this often appears to be unimportant (fig. 1). However, when these trees are examined more closely, it is found that the charred bark adheres to dead wood. By the third year rot will start its work.

It may take as long as 4 years after a fire for rot to reach the heartwood, but once there it will spread steadily upward at rates varying from a few inches to nearly a foot a year. Thus what should be the most valuable part of a tree is rendered completely worthless after 15 to 20 years.

The amount of rot to be expected in the butt log of a tree depends largely on the size of the original wound and the time elapsed since the fire. When over 100 wounded trees were examined shortly after the Sturdivant fire, it was found that in white oaks and bitter pecan the area of the wound was nearly the same as the area of the bark char (ratio 1:1). In red oaks, the wound was generally 2½ times as high as the bark char, though the width of red oak wounds was about the same as the width of the char.

Should Damaged Trees be Kept in the Stand?

Death in larger hardwood trees can be determined without much trouble. But when a valuable tree is only wounded, the forest manager must decide if he can safely leave it for further growth or if he should salvage it before decay sets in. Experience with the Sturdivant fire yielded some suggestions for cruising or marking fire-damaged hardwood timber.

Trees killed or seriously damaged by the fire should be salvaged as soon as is feasible, with due consideration for the cutting cycle, and the vigor and length of stem of each affected tree. But generally a tree should be salvaged if:

1. The bark is charred for more than 6 feet above the stump (regardless of the width of the char).
2. The char extends around more than half of the tree's circumference and reaches more than 2½ feet above the stump.

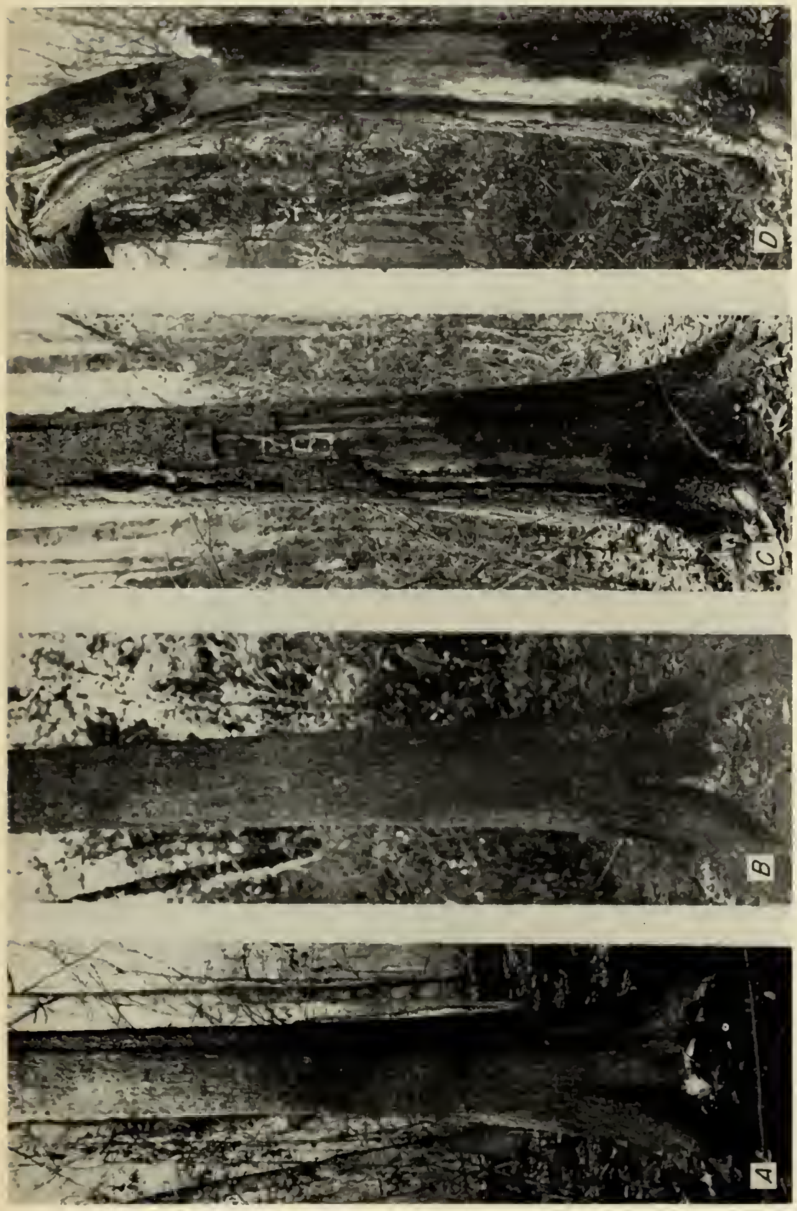


FIGURE 1.—*A*, The hardwood may appear little damaged immediately after a fire. *B*, 1 year later, cracks appear in bark. *C*, 2 years later, bark begins to fall off. *D*, 3 years later, rot starts its work on the underlying sapwood, and stem breakage may occur.

In estimating the extent of rot behind older wounds, and the rot to be expected in the future, it is helpful to keep in mind that, on the average:

1. Rot does not start in the heartwood until 4 years after a fire.
2. Wounds less than 2 inches wide are not important as a source of rot.
3. Rot exceeds hollow length about 2 feet.
4. Rot exceeds butt bulge about 3½ feet.
5. In 10 years, rot will extend 1½ feet above the original scar if about ¼ of the tree's circumference was damaged. If more than ¼ of the circumference was damaged, the rot may go higher.

FIRE ALWAYS HURTS HARDWOODS

The Sturdivant fire was put out more than 3 years ago, but research on it and other burns has settled once and for all some facts that seem obvious but are often forgotten. In hardwoods, there is no such thing as a harmless fire. All fires fry the reproduction and wound the larger trees. Any wound bigger than a silver dollar is probably going to admit rot that will surely destroy the valuable butt log.

Hardwoods are indeed hapless in the face of fire.

☆ ☆ ☆

Tractor Tilt Indicator

H. A. Yocum has designed and installed a simple device on our crawler tractor that indicates the angle of tilt on a side slope. This practical indicator may be more useful than most of the commercial tilt indicators available. It particularly lends itself to adaptation for the wide range of stability between the various tractors used by the service.

The device is a plumb bob that swings inside a slotted bar with a dial behind the plumb bob. The plumb bob swings from the hood above the instrument panel. The slotted bar is fastened to the hood with brackets and bolts holding it tight against the instrument panel. This bar prevents the plumb bob from swinging away from the instrument panel when the tractor is traveling upgrade.

The dial consists of five segments of a circle painted in three colors on the instrument panel. The extreme limits of the green center segment indicate 15-percent slope; of the two yellow segments, 30-percent; and of the two red segments, 45-percent. This calibration allows a large safety factor. On other tractors, and under other operating conditions, a different calibration may be preferred.

While the plumb bob is swinging in the green, no special safety precautions are required of the operator. When it swings into the yellow, he is required to start slowing down from maximum operating speed. When it swings into the red, he should come to a stop or nearly so, pick a less precipitous route, and proceed at a speed of not over one mile per hour until safer ground is reached.

There is a slight amount of friction between the guide bar and the plumb bob except when the tractor is perfectly level. The plumb bob won't hang up, however, even when the tractor is going up or down very steep slopes, because the constant movement and vibration of the machine continually shakes it free.

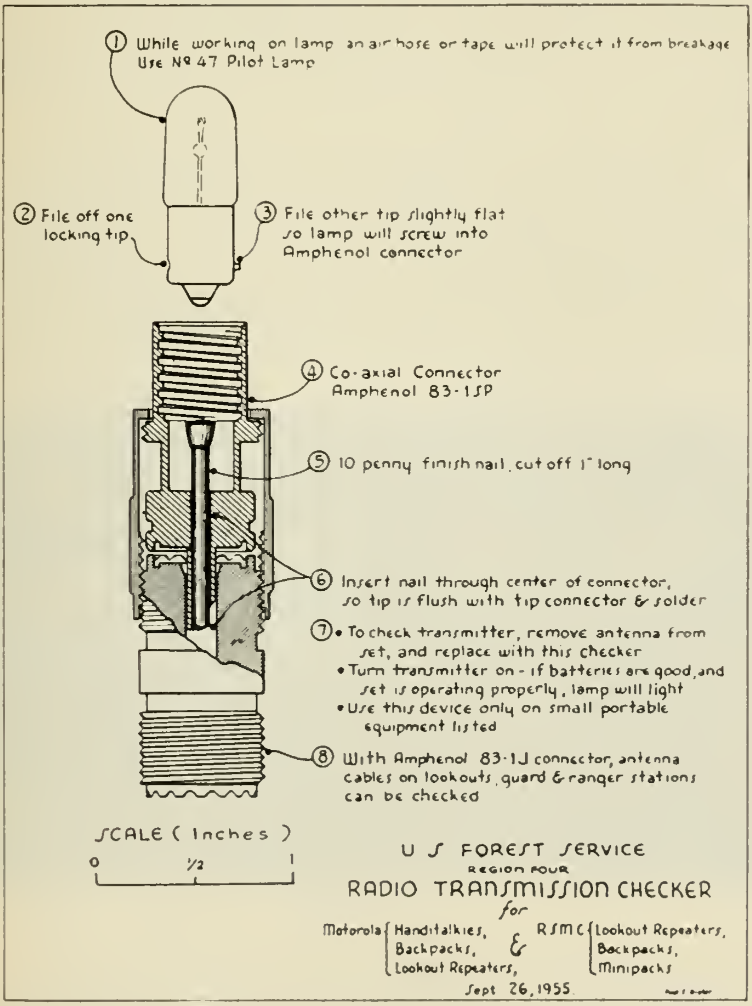
This device has worked satisfactorily, and we feel it can be effective in reducing potential tip-overs, and is particularly useful for operator training purposes.—H. H. MUNTZ, *Southern Forest Experiment Station.*

RADIO TRANSMISSION CHECKER

JOHN BARKDULL

Communications Technician, Boise National Forest, R-4

The radio transmission checker, as illustrated, has been made and used extensively in Region 4 and was found to be satisfactory. It is also used with an amphenol 83-1J connector for checking antenna cables. The cost of the unit is approximately $1. This checker will give nontechnical personnel a simple visual means for determining whether the portable radio transmitter is operating with normal output.


① While working on lamp an air hose or tape will protect it from breakage Use Nº 47 Pilot Lamp
② File off one locking tip
③ File other tip slightly flat so lamp will screw into Amphenol connector
④ Co-axial Connector Amphenol 83-1SP
⑤ 10 penny finish nail, cut off 1" long
⑥ Insert nail through center of connector, so tip is flush with tip connector & solder
⑦ • To check transmitter, remove antenna from set, and replace with this checker
• Turn transmitter on - if batteries are good, and set is operating properly, lamp will light
• Use this device only on small portable equipment listed
⑧ With Amphenol 83-1J connector, antenna cables on lookouts, guard & ranger stations can be checked
SCALE (Inches)
0
1/2
1
U S FOREST SERVICE
REGION FOUR
RADIO TRANSMISSION CHECKER
for
Motorola Handitalkies, Backpacks, Lookout Repeaters,
&
RSMC Lookout Repeaters, Backpacks, Minipacks
Sept 26, 1955

BRUSH SAWS FOR "HOT SHOT" CREWS

MICHAEL A. ROBERTS
Foreman, "Hot Shot" Crew, San Bernardino National Forest

The "Hot Shot" crew was organized to be a well-trained, fast, hard-hitting line hand crew. Toward this goal foresters are always alert to ways and means for securing faster and better results in fireline construction with less fatigue for such a crew. It is well known that line construction with brush hooks and axes is good but very slow and tiring. The problem of converting chain saws for use on brush, particularly on northern slopes in southern California, was thoroughly considered, and when trial proved this type of saw effective, a number were purchased for this use.

The 2½ horsepower chain saws had a 16-inch bar and Oregon chipper type chains; the Oregon XX type chain was also purchased. Only one piece of brush could be cut at a time with this type of chain saw because of the hazard of hitting the end of the saw on other brush, which made the saw jump back and endangered the operator. To reduce this hazard and make the saw more effective a bow type attachment was purchased (fig. 1). The chain saw demonstrated on the fireline that it would cut ½-inch brush up to very heavy oak 12 inches in diameter with ease.

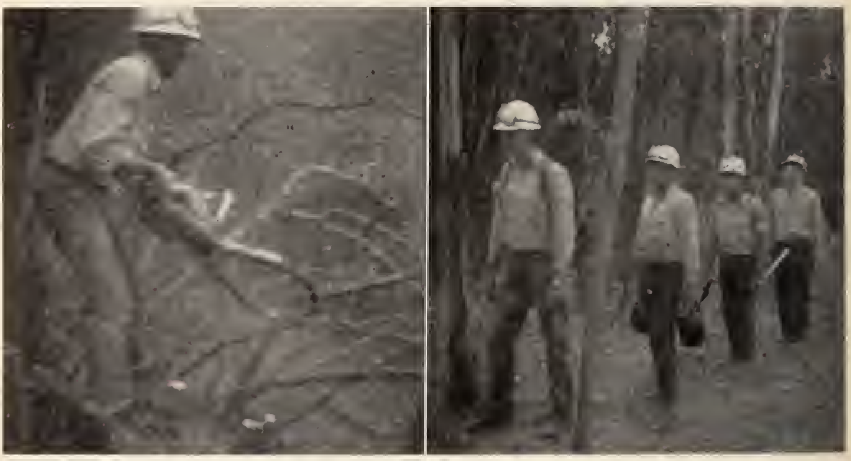


FIGURE 1.—*Left*, Saw with bow type attachment cutting brush. *Right*, Brush saw team packing in.

Teams of four men work together. One man operates the saw while the other three team members throw the brush the operator cuts. A man works as an operator for half an hour at which time another member of the team takes over his job. In the development of these teams problems of safety were encountered. A training program was necessary to teach the teams working together how to use these saws, since the group must be ever conscious of the hazard of the chain saw while in operation.

Transporting the brush saw to the job assignment was the next problem. A rucksack, used as a carrying case, proved very satisfactory for its weight of only 30 pounds. An extra quart of oil, a quart of gear oil, extra chain, and tools fitted easily into the extra pockets on the bag. A piece of 1½-inch condemned canvas hose was used to make a guard for the chain.

Judging by the work accomplished in using these brush saws, we would recommend that they be tried by all "Hot Shot" and other organized crews. Brush saws can be effective, and once tried may well take an important place on the fireline.

☆ ☆ ☆

Transporting Box For SF Handi-Talkie Radiophone

A metal box lined with sponge rubber to protect a SF handi-talkie radiophone while being transported by motor vehicle has been developed on the Black Creek Ranger District by Mechanic's Helper Elisha Bond (fig. 1). One radiophone was carried in such a box in a Forest Service pickup for 18 months without developing mechanical failures. In addition to the protection afforded by the shock-absorbent qualities of the sponge rubber, the radiophone is also protected from dirt and dust.

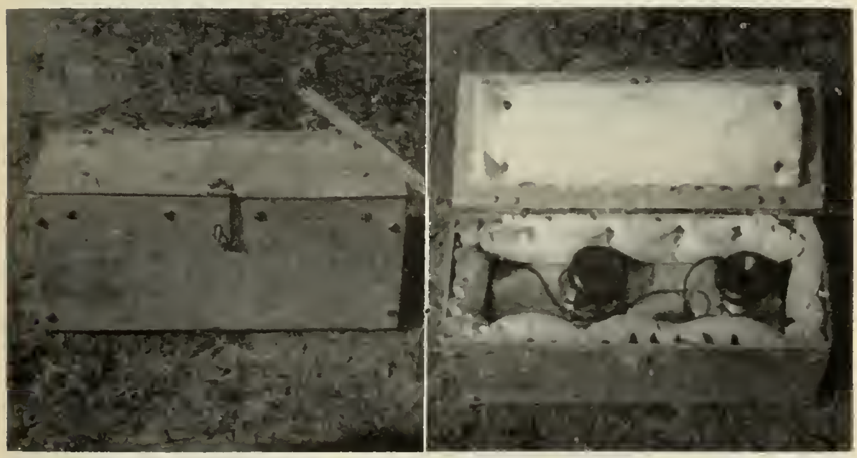


FIGURE 1.—*Left,* Closed radio transportation box constructed of aluminum plate. *Right,* Opened box showing lining of sponge rubber and radiophone in place.

The box is constructed of ⅛-inch aluminum plate and is lined with 1¼-inch sponge rubber. Although the sponge rubber was bolted to the box, an adhesive could be used satisfactorily. A box 16 inches long, 6½ inches wide, and 7½ inches high will accommodate the SF handi-talkie radiophone. It is recommended, however, that the box be built 19 inches long so that a spare set of batteries can be stored in the container. The cost of the box is more than offset by the savings in radio repairs during a one-year period.—DONALD A. POMERENING, *District Ranger, Mississippi National Forests.*

TRUCKS FOR "HOT SHOT" CREW ON THE SAN BERNARDINO NATIONAL FOREST

Michael A. Roberts
Foreman, Del Rosa "Hot Shot" Crew, San Bernardino National Forest

Equipment plays an important part in the effectiveness of a fire fighting crew. To assist the well-trained "Hot Shot" crew on the San Bernardino National Forest, trucks and equipment have been developed for their use. The basic equipment consists of a ½-ton pickup with seats and side rails and two 1½-ton stakesides with toolbox seats, completely equipped with handtools, portable radios, headlamps, rations, and two brush saws.

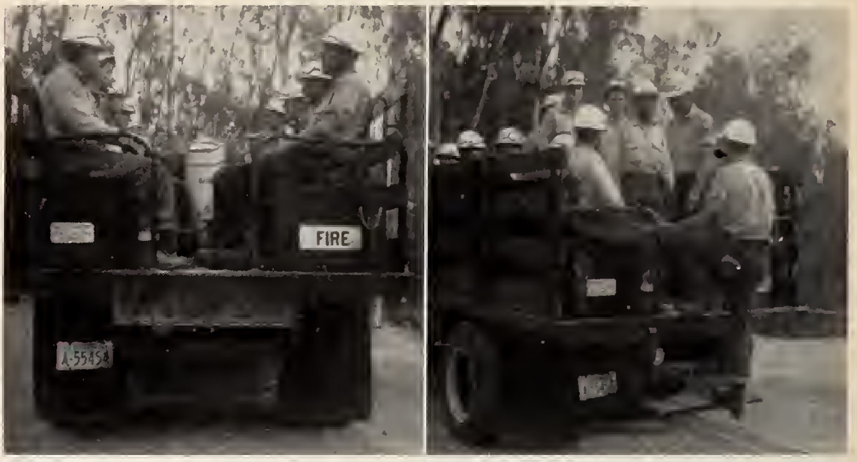


FIGURE 1.—*Left*, Truck ready to roll; rear step raised and in place for traveling. *Right*, Crew unloads by using handrails and the step developed at the Arcadia Equipment Depot.

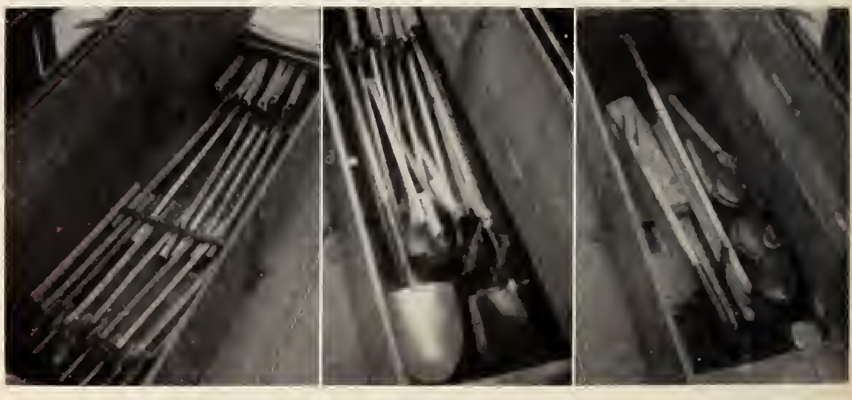


FIGURE 2.—Tools must be available for distribution in a minimum of time. These three toolbox seats contain brush hooks and double-bitted axes (note the used cotton hose as guards for exposed cutting-edges); shovels and pulaski tools; and McLeod tools, gas for brush saws, and extra chains.

Since a "Hot Shot" crew should basically be a self-sustaining unit, the following tools are carried on each crew truck:

Shears, pruning	pair	2
Brush bobbers		3
Hooks, brush		10
Pulaski tools		8
Shovels, long-handled, round-pointed.		10
Hose tool guards		24
McLeod tools		8
Axes, double-bitted		7
Saw, felling		1
Handles, saw		2
Wedges, wooden		4
Hammer, sledge, 4-pound		1
Oil, saw	quart	1
Saws, brush, chain		2
Chains, brush saw	extra	2
Fuel for brush saw, in safety cans	gallons	2
Oil, brush saw	quart	1
Oil, gear, brush saw	quart	1
Files		18
Hose, file holders		18

File guards		18
Handles, file		18
Canteens, 1-gallon		20
Lamps, electric, head		24
"A" batteries	carton	1
Fuses		24
Gopher gassers	carton	1
"B" batteries	extra	2
Radio, handi-talkie		1
Rucksacks		2
Knapsacks		9
Rations, emergency	boxes	2
Kit, first-aid, large		1
Kit, first-aid, cylinder		1
Kit, first-aid, belt		1
Kits, first-aid, pocket		7
Kits, snake bite		4
Water cooler, 15-gallon		1
Dispenser, paper cup		1
Extinguisher, fire		1
Blocks, chock		2

With this equipment available, the crew can use the truck as an operating base during the initial work period. Damaged tools may be exchanged for new ones. Damaged tools should be replaced as soon as the crew returns to the fire camp or headquarters.

The crew trucks are designed to carry men and tools safely to the fire. After arrival crews must unload as quickly as possible for the initial attack (fig. 1). Tooling up and hitting the fire must take only minutes (figs. 2 and 3). Additional information about the equipment and its arrangement may be obtained through the Forest Supervisor, San Bernardino National Forest, P. O. Box 112, San Bernardino, Calif.

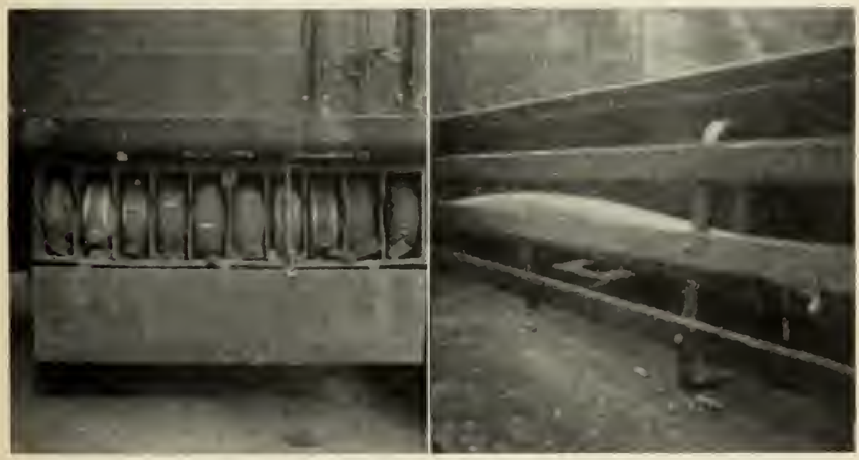


FIGURE 3.—*Left*, Two canteen boxes, one installed on each side underneath the truck bed, keep water cool. *Right*, A felling saw.

MECHANICAL TRAIL PACKER HITS THE SILK

A. B. EVERTS
Equipment Engineer, Division of Fire Control, Region 6, U. S. Forest Service

[This progress report illustrates the appeal and versatility of use of automotive trail transportation equipment.]

In the July 1955 issue of *Fire Control Notes,* District Ranger Parks of the Payette National Forest reported on "A Mechanical Mule." In a footnote the editor remarked, "At least five other models of this versatile machine are being designed, tested, or produced by private and government agencies." This article reports on one of the commercial models and some of the modifications that have been made to it (fig. 1).

There are at least 30 of these machines in use in the region, most of them by trail crews. They are so common that they are no longer a topic of conversation and it is quite probable that we have not heard some of the interesting stories regarding their use. Packing lookouts in and out of their stations is commonplace. Considerable ingenuity has been exercised by various individuals for improving the units for trail use. Stands of various kinds have been devised to hold the loaded packer upright while loading and unloading, and during trail stops.

The Wenatchee Forest has one equipped with a winch which is used to pull out small stumps on a trail construction job. This forest has also recently completed a project in which they have modified a packer into a mobile trail compressor unit. The unit, complete with compressor, drill steel and bits, jackhammer and accessories, weighs 655 pounds, including the weight of the packer.

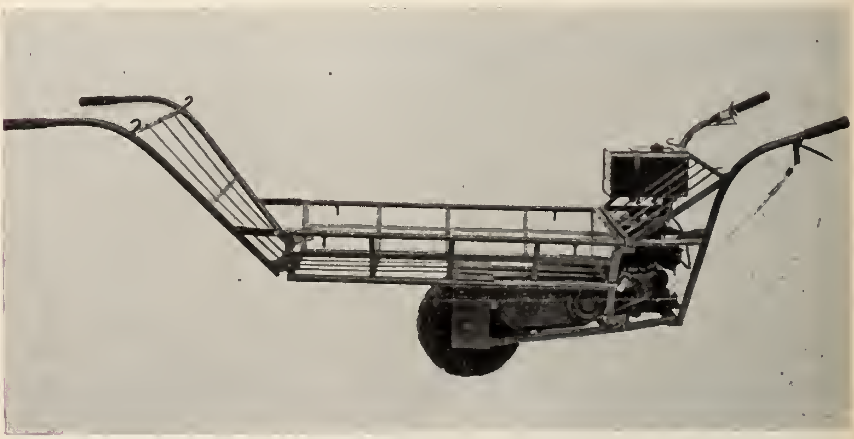


FIGURE 1.—This model of the packer weighs 175 pounds and is powered with a 2½-hp. 4-cycle motor. Gasoline consumption is 16 miles to the gallon; two speeds, 5 m.p.h. and 2½ m.p.h. Present cost is $175 f.o.b. factory.

The Mt. Hood Forest has used the packer for transporting rolls of paper for covering brush piles in connection with a clear-cut slash-disposal experiment. It was also a Mt. Hood 2-man trail crew that made a 70-mile, 10-day trail-opening expedition in which all their tools and supplies were transported on a packer.

The Wallowa-Whitman Forests have a trail kitchen packer, complete with plywood built-ins, that brings a touch of convenience, if not luxury, to an isolated camp (fig. 2).

We have not yet heard of anyone using the packer as a pumping unit or for transporting portable pumps into a water "show." If it hasn't been done, it's just a matter of time, along with a lot of other uses.

The manufacturer of the packer has a companion unit called the "trail grader," which is giving excellent results on trail construction jobs. This unit has considerable promise as a fireline digger and, while we do have some figures on rates of fireline construction, we are not yet ready to release the unit without more field experience. We do believe that in many types of fuel the grader will do the work of six to ten men with handtools.

Also now, Francis Lufkin, Aerial Project Foreman of the North Cascade Smokejumper Unit, has brought up the idea of using the packer to retrieve smokejumper equipment. What's more; Lufkin has demonstrated that his idea is sound.

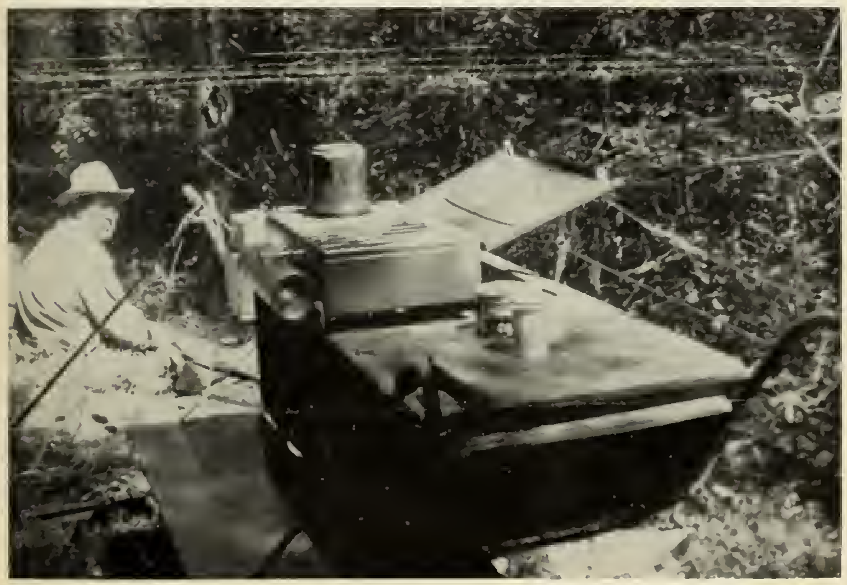


FIGURE 2.—The Wallowa-Whitman Forests trail unit with built-in plywood box. Complete unit includes the following equipment: Two axes, 1 hazel hoe, 1 crosscut saw, 1 pruning saw, 2 canteens, 3 sleeping bags, 3 knapsacks (personal), 3-man mess kit, 1 gasoline lantern, 1 gasoline two-burner stove, 1 tarp, groceries for three men for one week. Approximate load is 300 pounds.

A smokejumper's "come-out" equipment, including his fire tools, which are dropped to him, weighs about 105 pounds. This is a sizeable load, even for the young huskies that hit the silk on these back-country fires.

In times past, it was the procedure for the jumpers to backpack their equipment out to the nearest trail where it would be picked up by a packstring. This still occurs to be sure, but in this changing world packstrings certainly aren't increasing in number, and packing is beginning to be spoken of as a "lost art." There are still plenty of mules. The same cannot be said of packers, however. The result is that on many fires the jumpers backpack their equipment "all the way out."

Mr. Lufkin wants to change this, at least on the long packs, and it looks as though he's going to do it. He made some changes in the packer:

(a) Changed the clutch arrangement to contain its own tighteners and for easier control.

(b) Added side stands to hold the machine upright while motionless.

(c) Added a crazy wheel in the rear to eliminate the need for fore and aft balancing.

Then Mr. Lufkin devised a way to break the machine down into two parts since, with the accessories, it was too heavy and too awkard to get it out of the aircraft door easily (fig. 3).

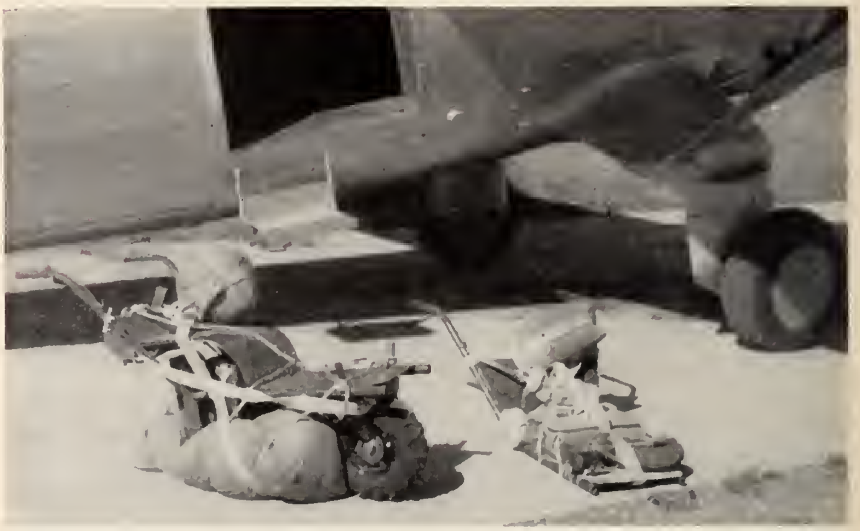


FIGURE 3.—Packer, in two sections, packaged for dropping. Note the padding under the engine on the left-hand section, designed to lessen the landing impact.

There was one more important step: training. After successfully completing test dropping, a few of the jumpers were given training in assembling the unit, how to start the engine, how to use the clutch and tighten the belt, etc. They had confidence in the machine before it ever came drifting down to them "out of the blue," as it did shortly afterward on the Hungry Ridge fires. There were two fires, both started by lightning, a little over a quarter of a mile apart. Four jumpers went down, two to a fire. They got their fires and mopped them up. Then they loaded their equipment on the packer, 410 pounds of it, and headed out (fig. 4).

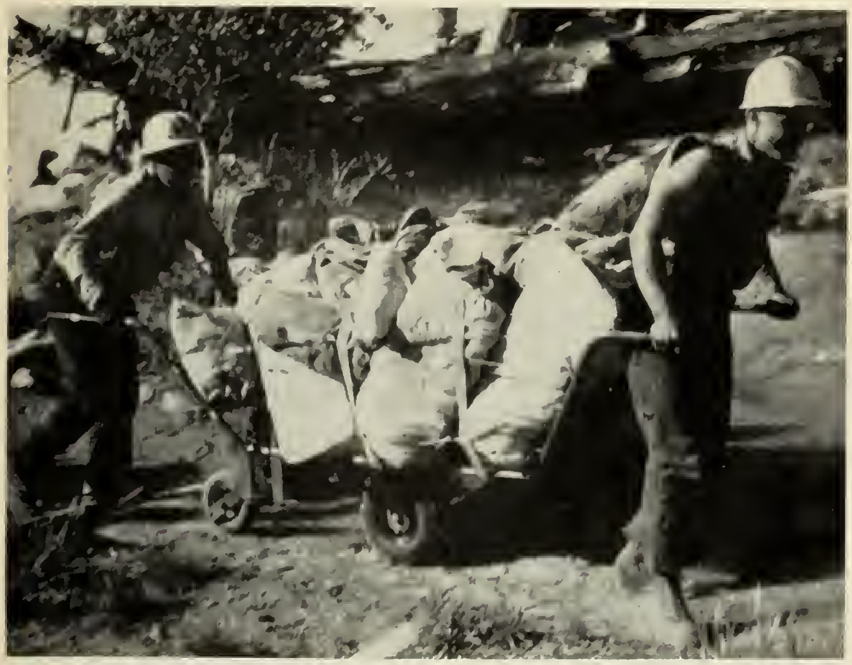


FIGURE 4.—Smokejumpers coming out from the Hungry Ridge fire over an old sheep driveway.

The packer has its limitations, but its area of operation is increasing. Region 6 is beginning to talk about better trail maintenance, a different kind of a water bar. Fording streams is a problem. The Wenatchee Forest personnel say that in many crossings they can solve this by a small cable stretched across the stream. They simply hook the packer to the cable and skyline it across, load and all.

There is no doubt about it; the mechanical trail packer is here to stay. It's not at all improbable that within 5 years one or two of these units will be standard equipment at many ranger stations, at least on those districts that have an extensive trail system. You will hear repeatedly as you talk to the boys who are pioneering their use, "Sure, there's work connected with them. So what! You don't have to round 'em up when you crawl out of the sack in the morning. And you don't have to feed 'em all winter long like you do the long-eared hay burners."

FIRE HEADQUARTERS SUPPLY CABINET

JOHN A. ANGUILM
Assistant Regional Supervisor, Region 1, Michigan Department of Conservation

A few years ago 3 extra-period fires, i. e., fires not controlled by 10 a.m. of the day following discovery, taught us the desirability of having a well-organized and well-equipped fire headquarters supply cabinet ready to roll on a minute's notice. Such a cabinet was designed and built for us by our Central Repair Shop at Gaylord, Mich. (fig. 1).

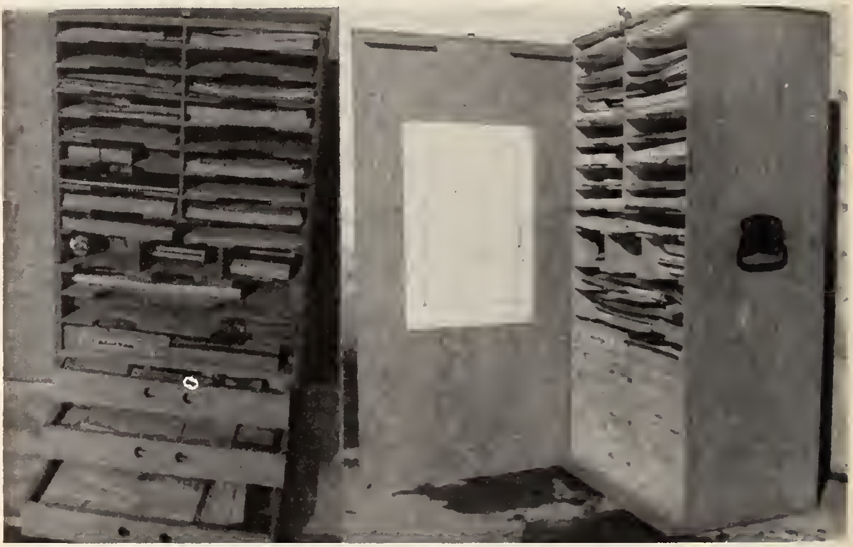


FIGURE 1.—Fire headquarters supply cabinet.

The cabinet is made of ½-inch plywood with ¼-inch dividers and is 19 inches wide, 36½ inches high, and 12 inches deep. Its removable door recesses into the box foot and fastens at the top with a trunk-type fastener. On a fire, this door serves as a tabletop; a layout of the box is posted on it (fig. 2).

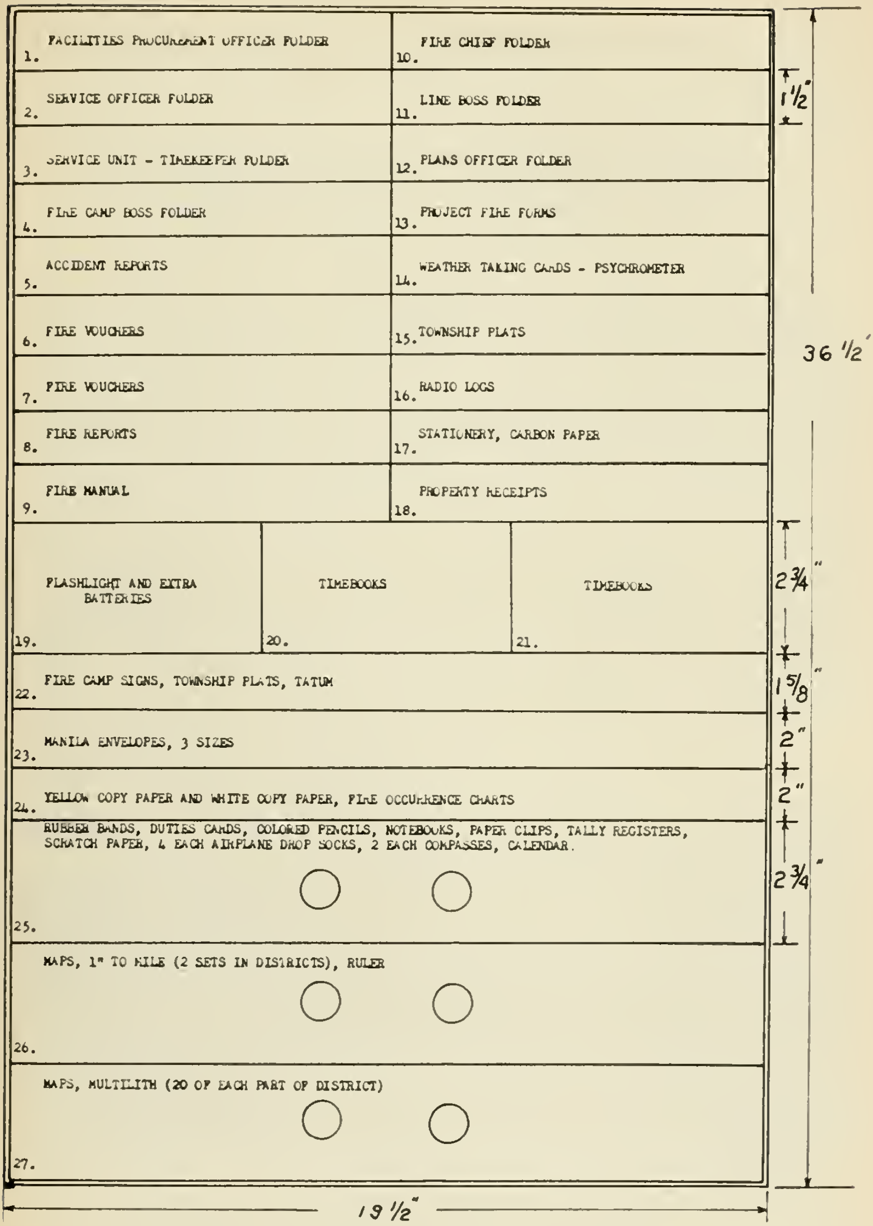

1. FACILITIES PROCUREMENT OFFICER FOLDER
10. FIRE CHIEF FOLDER
2. SERVICE OFFICER FOLDER
11. LINE BOSS FOLDER
3. SERVICE UNIT - TIMEKEEPER FOLDER
12. PLANS OFFICER FOLDER
4. FIRE CAMP BOSS FOLDER
13. PROJECT FIRE FORMS
5. ACCIDENT REPORTS
14. WEATHER TAKING CARDS - PSYCHROMETER
6. FIRE VOUCHERS
15. TOWNSHIP PLATS
7. FIRE VOUCHERS
16. RADIO LOGS
8. FIRE REPORTS
17. STATIONERY, CARBON PAPER
9. FIRE MANUAL
18. PROPERTY RECEIPTS
19. FLASHLIGHT AND EXTRA BATTERIES
20. TIMEBOOKS
21. TIMEBOOKS
22. FIRE CAMP SIGNS, TOWNSHIP PLATS, TATUM
23. MANILA ENVELOPES, 3 SIZES
24. YELLOW COPY PAPER AND WHITE COPY PAPER, FIRE OCCURRENCE CHARTS
25. RUBBER BANDS, DUTIES CARDS, COLORED PENCILS, NOTEBOOKS, PAPER CLIPS, TALLY REGISTERS, SCRATCH PAPER, 4 EACH AIRPLANE DROP SOCKS, 2 EACH COMPASSES, CALENDAR.
26. MAPS, 1" TO MILE (2 SETS IN DISTRICTS), RULER
27. MAPS, MULTILITH (20 OF EACH PART OF DISTRICT)
1½"
36½'
2¾"
1⅝"
2"
2"
2¾"
19½"

FIGURE 2.—Supply cabinet layout.

SIMPLIFICATION IN DISPATCH SYSTEMS

Max A. Bradley and Gilbert I. Stewart
Michigan Forest Fire Experiment Station, Michigan Department of Conservation

From the beginning, organized forest fire control in North America has depended upon fire detection and map systems. These, differing somewhat in detail according to the agencies involved, have remained basically the same. Detection has come chiefly by actual observation of fires from elevated positions—ultimately towers—strategically located. Fire finding instruments have also differed greatly, even though variations are chiefly refinements. All detection systems utilize "cross shots" from two or more towers measured in azimuth directions. When these readings are plotted on a dispatch map at some headquarters, the map location of a fire is established. Until this is done, initial action on suppression cannot be undertaken efficiently. However, once the map position is established, a great deal of efficient action can start promptly, for not only is the location known, but also associated information is available immediately dealing chiefly with base features, forest cover, and water supplies.

Functions of detection cannot be separated from those of dispatch, and good map systems constitute the basis of all effort in these fields. Completeness and accuracy are essential in maps themselves, but equally important is the accuracy of plotting azimuth readings from tower sightings.

Almost without exception surfaces of dispatch maps have been dominated by azimuth circles stamped, printed, or pasted upon them, the center of each circle indicating the position of a tower. In those instances where towers were located fairly near each other, circles overlapped or became so numerous that base features were seriously blocked out. Usually, reconstructions of tower readings were made with cords stretched from the centers of the azimuth circles concerned, and crossed to establish the map positions of fire. Even though the desired results were obtained in establishing positions of fires, many disadvantages have been recognized.

The Michigan Department of Conservation recently undertook to investigate means of improving instrumentation of fire detection, as well as map systems employed in dispatch. Investigative work was broken down into two major phases; fire finding instruments and map systems.

Improved types of fire finding instruments were reported upon in *Fire Control Notes* for April 1955. Work progressed simultaneously on map systems, and in May 1955 all map methods existing prior to that time were declared obsolete, to be supplanted by a new system as soon as replacement maps could be issued.

The study of existing methods brought out that improvements could be attained only if the following features could be assured:

1. Accuracy must be assured in reconstructing cross shots from towers. Also accuracy should be consistent and comparable with that guaranteed by fire finding instruments.
2. Full details of base features must remain visible, not obliterated by azimuth circles.
3. Maps must be replaced less often, their details protected from fading as much as possible, and their surfaces shielded from abrasion and dirt.
4. When replacement of maps becomes necessary no changes should occur in the positioning of markings from which azimuth readings are taken.
5. Means should be provided for setting off two or more simultaneous readings from any tower if it should be concerned with more than one fire at the same time.
6. The system of "Cross out" must not require pencil marking on the surface of a map, nor mar its surface by holes from pins, thumb tacks, or other markers.

Obviously the old methods could not be retained, and accomplish these improvements. By May 1955 an improved method had been developed. Its workability depended upon a new instrument combining an arm or arrow and an azimuth circle. This instrument, which has been called the "protractor arrow," was designed and perfected at the Experiment Station (fig. 1). It assured realization of all requirements listed above.

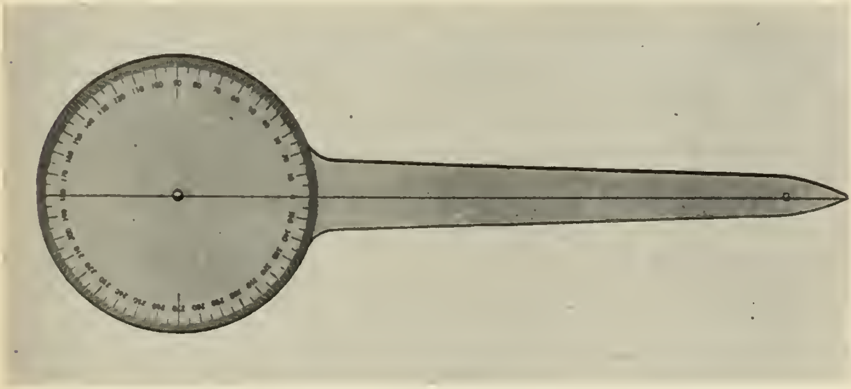


FIGURE 1.—The plastic "protractor arrow."

The protractor arrow was designed for production in transparent plastic, and several custom-made samples proved its practicality. Detailed specifications were formulated at the Experiment Station and, along with drawings, submitted to manufacturers. Satisfactory bids and estimates were received, and subsequently 1,500 of the instruments were ordered (fig. 2).

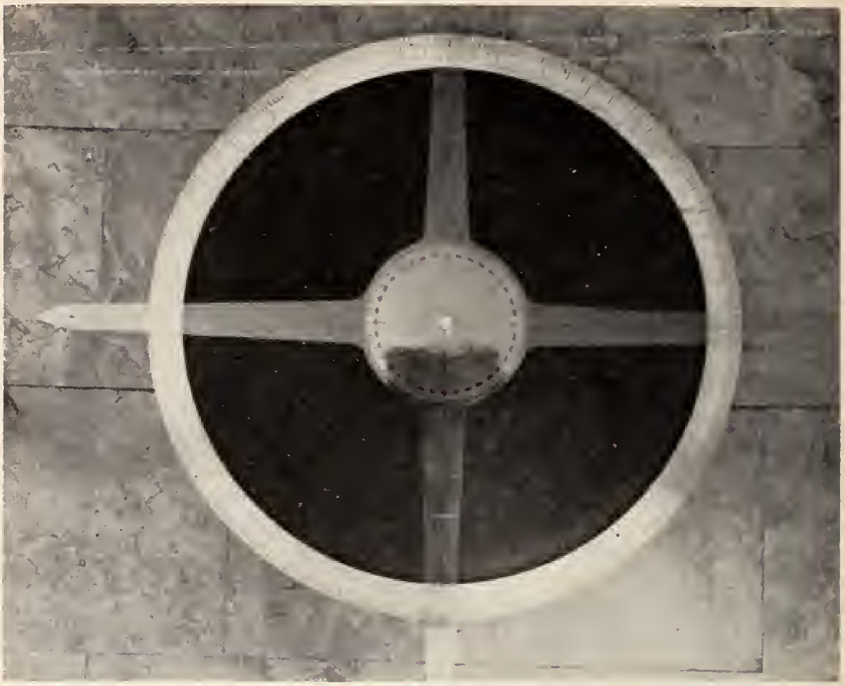


FIGURE 2.—A graduated gage was developed for testing the accuracy of protractor instruments. They were checked against each other in stacked position and on the gage as well.

The new maps bear no azimuth circles on their surfaces. Each map is mounted on relatively soft composition board that is laminated to a hard backing panel known as Novoply. The lamination is ⅞-inch thick, and the entire panel is framed with light aluminum channel. A plastic coating is applied by brushing the surface of the map. It dries hard, clear, and transparent, leaving every map detail clearly defined and visible.

At the time of map printing, each tower location was marked with a short line extending north from the tower position. After maps were mounted and framed, a small hole was drilled at each tower location (fig. 3), threaded screw posts were pressed, friction tight, into these holes from the back of the map panel. Thumb screw studs can be inserted into them from the face of the map. Each protractor arrow is center-drilled to accept the screw stud; it can be clamped against the surface of the map and held in any position required by the azimuth reading (fig. 4). The "zero" or north line serves as the orientation point for any desired protractor setting.

At the present time six protractor arrows accompany each dispatch map; more can be issued with larger maps that include greater numbers of towers. Ultimately all maps used on towers will conform to this same system, and three to six protractor arrows should serve the need of each tower. Any arrow can be

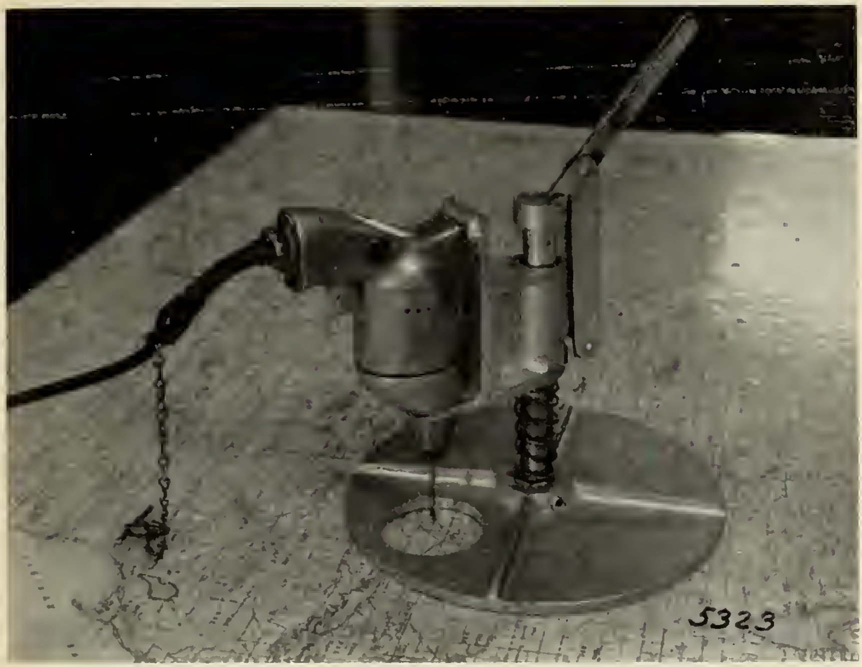


FIGURE 3.—Equipment developed for drilling map panels at tower locations. It is essential that every hole be accurately centered and drilled in exact alinement with the "zero" line already placed on the map surface. The circular opening in the base of the stand contains a transparent disk; a locating hole insures placement of the drill directly over each tower location.

moved about at will, and clamped at any tower location. If any one tower should be involved in more than one fire at the same time, arrows can be stacked on that particular screw post, and made to point in the required number of directions. The system can be used identically at all dispatch headquarters and towers.

A project to produce all of the dispatch maps required for issue to field headquarters and administrative offices throughout the State was finished in October 1955. All maps will be put into service for the fire season of 1956.

Changeover to this new method made obsolete all existing dispatch maps. However, future economy will be realized in a number of ways. Map replacement is expected to be much less frequent. The plastic protractor arrows are of high quality and should be usable for 10 years. When crossed, the centerlines of arrows establish the location of a fire very clearly; the setting can remain fixed as long as desired, and no marking of any kind need be made on the map surface. All techniques utilizing cords, with their attendant weights, springs, magnets, and stick pins are eliminated.

The protractor arrows have printed figures sandwiched between two layers of plastic. Graduations are very accurate, and permit plotting azimuth readings with no instrumental error. The

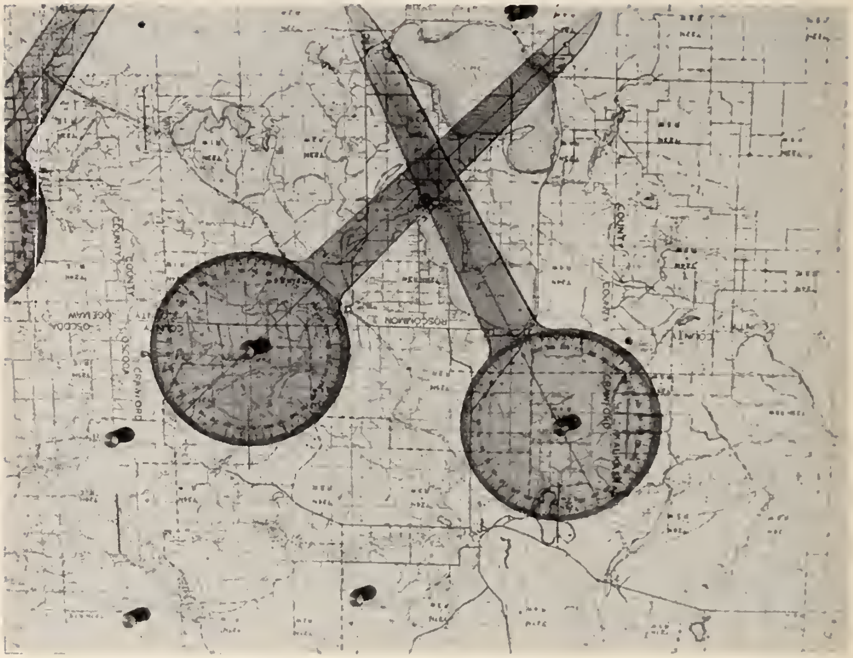


FIGURE 4.—Each tower location on the dispatch map is provided with a base screw post. Thumb studs screw into them from the front of the map and clamp the protractor arrow in any desired position. Note the concise intersection of center lines. Surface of the map is completely free of any other details that detract from map purposes.

azimuth circle is 5 inches in diameter, total length of instrument is 14½ inches, thickness is .060 inch. The material is classed as clear vinylite. Further information can be obtained from the Michigan Forest Experiment Station, Michigan Department of Conservation, Roscommon, Mich.

SELECTING AND TRAINING DISTRICT FIRE WARDENS

Francis L. Coyle

Forestry Aid, Mio Ranger District, Lower Mich. National Forest

A successful warden force depends upon the men selected. They should be picked for leadership, ability to get along with people, geographic location, availability, and willingness to cooperate with the Forest Service. Just because a man lives in an area where a warden is needed and has a telephone does not make him a competent warden. Even if he has had experience on fires and is well acquainted with his zone, if he is unwilling to cooperate or to follow orders he is of little use.

After selection the warden's importance in the fire suppression program should be made clear to him. He should know that he was selected because he is respected by his neighbors, because of leadership abilities, because of good judgment, and because of willingness to cooperate. District personnel should visit their wardens when in the locality whether during the fire season or not. Regardless of the occupation a warden may have—farmer, businessman, logger, or resort owner—he should know we are interested in him and are depending on him. His Fire Warden sign should be prominently displayed, and his fire cache box should be kept in a neat condition.

To train new wardens and to bring experienced wardens up to date, warden meetings are usually held annually. An all day meeting should be planned to present the latest skills, techniques, and new equipment for fire fighting. Although our wardens do not receive pay either for their time or mileage, we have almost 100 percent attendance. This is in spite of the fact that some of the wardens drive 30 miles one way and most of them lose a day's work. This is partly because our wardens realize we are proud of them—and we don't hesitate to tell them so!

The first hour is usually spent in introductions; in passing out warden cards, books of burning permits, franked envelopes, and zone maps; and in having the wardens sign equipment agreements.

Next on the program is a discussion of last year's fires. Here again the wardens' work is stressed. Specific techniques that have proved helpful are pointed out. This leads logically to future work and methods by which the wardens can assist us in prevention as well as fire suppression. These include talking to people, posting fire prevention material in their zones, and advising their neighbors when it is safe or unsafe to burn. Fire fighters frequently have suggestions of value and their comments are encouraged.

If time is left before lunch, a movie on fire can be shown. Since new films are available, the same film should not be shown year after year.

After lunch take the wardens for a field demonstration on new equipment acquired since the last meeting. The men should be given a chance to use the equipment and to ask questions about its use. If new equipment or tools have not been acquired, the wardens can be organized for a project fire setup. Select a fire boss and explain the project through him. Instruct the group on how the fire boss should select his sectors and appoint such assistants as sector bosses, line bosses, tractor and tanker unit bosses, timekeeper, and radio operators. Each position and the reason for each one should be explained; maps and blackboard can be used to illustrate reasons for deployment of men and equipment. This simulated exercise can be made more interesting by such activities as having spot fires occur, and studying wind shifts. Questions and comments should be encouraged. In inclement weather this project can be held indoors.

No demonstration should last more than 2 hours. The final 2 hours of the meeting should be an open discussion. The wardens should know that we will support them. They have authority to issue burning permits, they may refuse permits if they believe it unsafe to burn. Also if some people in their zones burn promiscuously, we will do all we can to prevent further violations even if court action is necessary. At this time the wardens are asked to present their particular problems and we answer their questions if possible. If not, we get the answer for them at the first opportunity. Wardens should be asked for comments, suggestions, and criticism on the work of the Forest Service in fire prevention and control. The meeting should stop early enough so that those who have important chores, especially farm ones, can get home to do them. But anyone who still has questions can stay for help in their solution.

After the warden force has been set up, the wardens should be used as much as possible. They should be dispatched on any fire in their zones, even though a Forest Service crew could handle the fire. The wardens should also be used as reinforcement in adjoining zones; they should be utilized as much as possible as line or sector bosses on project fires. A good warden force can easily become a poor one, especially if fires occur in the wardens' zones and they are not used. Proper selection, training, and use of district fire wardens will result in a good warden force.

REFLECTIVE PREVENTION SIGN FOR PROTECTION VEHICLES

Martin E. Craine

Assistant State Forester, Utah Board of Forestry and Fire Control

While trying to take advantage of every known medium for the promotion of wildland fire prevention in Utah, one day we suddenly awoke to the fact that our own field vehicles were reaching into every corner of the State without carrying a direct plug for fire prevention. Immediate steps were taken to put this free advertising space to use (fig. 1).

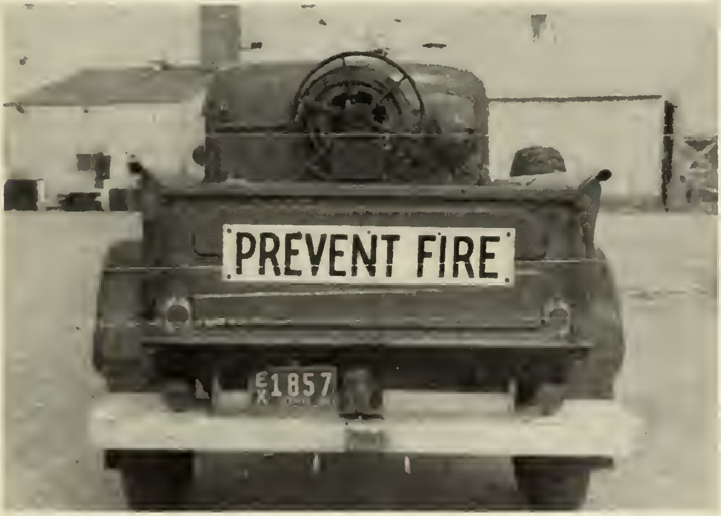


Figure 1.—Utah Board of Forestry and Fire Control reflective prevention sign. The first 5 signs were produced in the State Road Commission sign shop at a total cost for labor and material of $32.50, or $6.50 each.

The signs were to be as large as practical for the vehicle tailgates. We wanted the message in large letters, legible from a distance and hard to overlook. This demanded use of the shortest possible phrase. Each sign was to be a unit that could readily be removed from a vehicle for refinishing or for transfer as vehicles are replaced. We selected 8-gage metal for the base material. So it would be equally effective in hours of darkness, each sign was made of reflective material. The finished product is black letters on a white reflective background with overall dimensions of 10 by 48 inches.

ADJUSTABLE TRAILER HITCH ASSEMBLY FOR STAKE TRUCKS

Claude L. Smith

Equipment Repairman, Michigan Department of Conservation

Fire control people frequently find they need to enlarge their truck fleet in high hazard periods by renting private trucks. Among the jobs for these rented units is delivery of trailer-mounted fire pumps, plows, and pipe and hose outfits to fire locations.

Our Norway station requested a trailer hitch assembly that could be easily installed and removed from any stake truck they might procure for temporary fire duty. We made up the illustrated hitch in 1953 (figs. 1 and 2) and in 1955 produced 20 additional units for use at other stations.

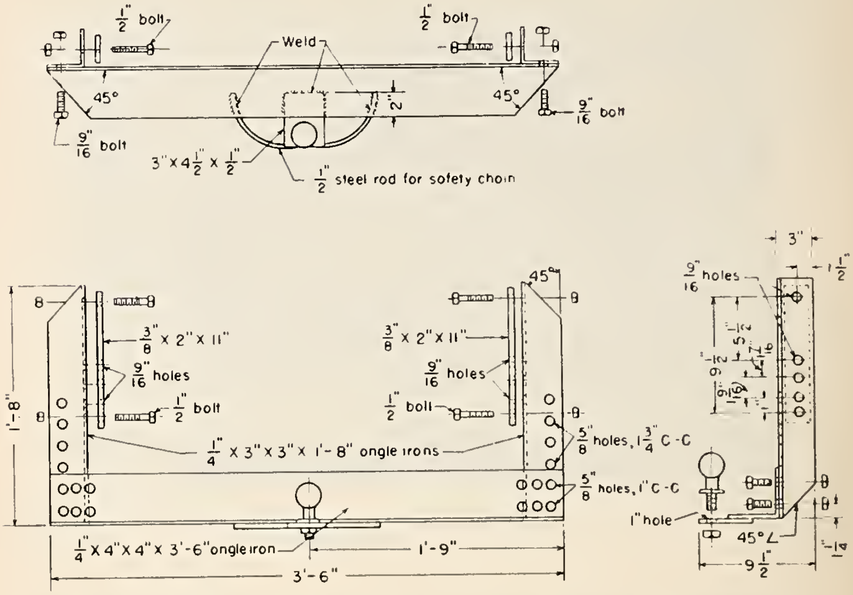


Figure 1.—Construction details of adjustable trailer hitch assembly.

This hitch is easily fastened (without boring holes) to the stringers of a stake truck by use of clamp plates. Several holes in the clamp plate and in the upright angle iron permit adjustment to a snug fit over the stringers. Holes drilled in the upright angle iron permit setting the hitch at the desired height. Extra holes drilled in the crosspiece of the hitch permit adjusting the width to the varying width between truck stringers.

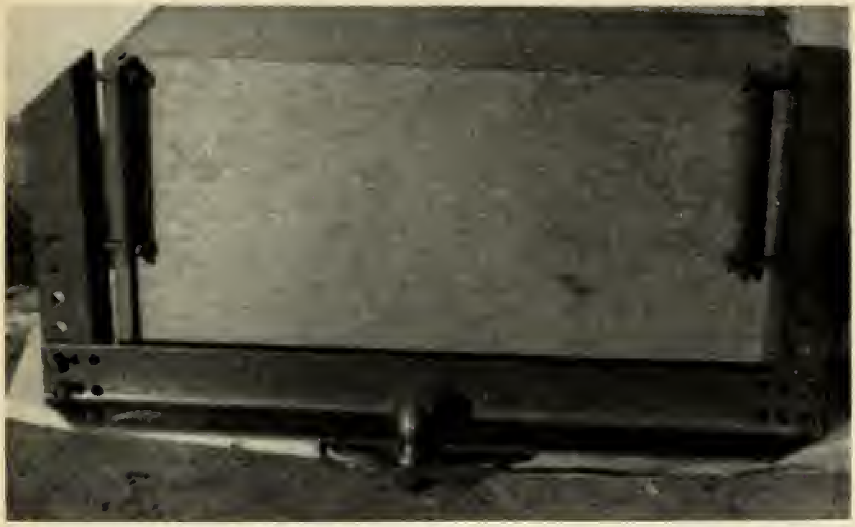


FIGURE 2.—Trailer hitch assembled.

CAUTION: This hitch is for temporary emergency use; because the bolts can work loose, the assembly should be checked frequently. Care should also be taken to see that the trailer is not loaded too heavily.

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Test-of-Friendship Fire

To the long and varied list of causes for forest fires, a new one was added last month.

The report comes from the Pleasant Hill District of the Ozark National Forest that a 59-year-old resident of that area set fire to his farm buildings last month to find out, as he told law officers, "if he had any friends who would come to help him put it out." Except for a crew of U. S. Forest Service men, no friends came. They controlled the blaze after it had spread over seven adjoining acres of National Forest land.

In court, the judge, prosecuting attorney, and witness were sympathetic. The old man was fined $25 for letting a fire burn to other lands, but a 90-day jail sentence was suspended, he was placed on probation for 6 months, and a charge of drunkeness was dismissed. Yet, on leaving the court of justice, the old man still seemed puzzled as to the extent and quality of his friendship.—*Quarterly Review*, Vol. VI, No. 4, Forest Service, U. S. Dept. Agr., Atlanta, Ga. Oct. 1955.

FIRE CONTROL PRACTICES: A TRAINING COURSE

Craig A. Giffen

Assistant District Ranger, Tahoe National Forest

For the past two years the Tahoe National Forest has used a different approach to fire control training at its annual fire training meeting. Several phases are integrated into one basic course for first and second year fire protection personnel. Classes are limited to five or six trainees each so that individual trainees can actively participate.

Prior to use of this method our fire training meetings depended on the lecture-demonstration type of class. Fire behavior, line location, line construction, initial attack procedure, mopup practices, and other courses were taught to groups of 20 to 40 trainees. Attempts were made to encourage individual trainee participation, but in too many cases most trainee activity was confined to looking and listening. Even the final crew-sized fire, culmination of our fire training meeting, took on the appearance of a demonstration for spectators. There was simply no opportunity for large numbers of trainees to actively participate.

Our new technique, called the "Fire Control Practices" course, is alloted about 3 days of our normal 4-day training meeting. A short orientation lecture and a required course in use of basic fire fighting handtools must precede it.

The 40 to 60 first and second year men attending are divided into groups of about 6 trainees each. Each group is assigned to an instructor who is assisted by a "demonstrator" and a "fire stopper." The more experienced personnel either attend specialized classes designed for their particular needs or they serve as demonstrators and fire stoppers.

The "Fire Control Practices" course aims to teach the principles of fire control by the use of many separate lessons. Each lesson stresses one principle or basic point in fire behavior, line location, line construction, initial attack, or mopup. Every lesson uses an actual fire. For the first several lessons very small fires are sufficient, maybe only a foot or two across, but the fires and the smoke are real. With classes small, interest is high. Informal explanation is necessary, to be sure, but an outdoor laboratory with lots of small fires is the key; individual trainee participation becomes a reality.

The first lesson might logically be a demonstration of fire behavior under the simplest possible conditions: No wind, no slope, and fuel of pure type and of uniform density and moisture. Grass or pine needles are very satisfactory and provide a good base for discussing the fuel-heat-oxygen triangle. The fire is started and the even rate of spread from the center in all directions is pointed out. The instructor asks for questions and answers them but does not become involved in other principles at this time. Handling these is planned for subsequent lessons. The instructor does not even put the fire out. He simply moves his class away from the area and his fire stopper steps in behind and mops up. If trainees are permitted to observe the suppression action, they will think about other things instead of the basic lesson at hand. Next, a trainee repeats the process with his own small fire and explanation. A critique completes lesson one.

The second lesson could demonstrate the effect of different fuel types or different fuel density on the rate of spread. An actual fire is used to show how heavier or sparser fuels affect its spread. No doubt the instructor will have to prepare his fuels a bit so that the principle can be adequately demonstrated under simple conditions. Slope, wind, and other factors should remain unchanged and should not affect the demonstration. Only one principle should be stressed. After questions have been answered, the group moves away from the fire. And again a trainee, preferably a different one, prepares similar conditions, lights his fire, and proceeds with a full explanation and demonstration of the principle involved. The critique completes the lesson.

Additional lessons in fire behavior follow, but each successive lesson stresses only one basic principle. Points which have been previously covered may be referred to as they relate to a current lesson, but principles reserved for future lessons should not be discussed until their time. Wind, slope, and fuel moisture can be covered in whichever order the instructor prefers. Sometimes windy conditions in the field will make it difficult to isolate this factor, but at least its influence can be seen and explained. Our experience has been that a good instructor can handle such unforeseen occurrences without excessive trouble. If the day is calm, wind can be generated by a portable fan and battery.

It is important that each trainee gets several opportunities to participate actively in both demonstration and explanation. This method of instruction with trainee participation is basically similar to the four-step method:

1. Instructor outlines the conditions and the lesson to be learned.
2. Instructor starts his fire and explains the key point.
3. Trainee presents similar conditions, starts his own fire, and explains the key point.
4. Follow-up is accomplished back on the ranger district as employee puts training into practice on going fires.

After the class has covered the basic points of fire behavior, the instructor proceeds, one point at a time, through the principles of line location. He explains how the various principles of fire behavior just learned affect the location of firelines. The presence of natural barriers, heavy or flash fuel, the proximity of slope, the problem of a fire just starting up both sides of a draw, and the effect of rolling material on a slope are just a few of the factors influencing line location that can be demonstrated by small fires.

The demonstrator should actually build what line is necessary, while the instructor explains the theory of a particular piece of line location but does not mention line building techniques. As lessons in line location progress, larger fires may be necessary so that realistic conditions can be had. Nevertheless, for each lesson a trainee should be required to move to a new spot (already picked out for proper conditions), light a new fire, and thoroughly explain the principle involved. He should use the demonstrator for actual line building just as the instructor did. And, of course, a critique is still necessary to conclude the lesson.

After several lessons in line location, the class may progress to the methods of line construction. As successive lessons are introduced the four-step method of instruction is adjusted somewhat in order that all trainees may participate in each line construction problem. Trainee activity is very closely supervised in these lessons since the demonstrator is able to spend part of his time assisting the instructor in the correction of unsound work methods. Fires are permitted to become larger now and the instructor is teaching basic points of the one-lick, progressive, and leap frog methods of line construction. Since trainees have been introduced to the use of basic tools in a previous course, line construction lessons move along fairly rapidly with plenty of fire and lots of smoke. Mopup work is still done by the fire stopper who may now have a small tanker at his disposal, but all trainees work on the control line.

By now trainees are beginning to perspire and they may even develop a smoke eater's cough. Small groups and many fires have made possible an understanding never before reached by spectator training.

The instructor has now had a couple of days to size up his crew and to determine how much more training they can take and at what speed. Principles of initial attack and mopup are still to come. Perhaps several major points can now be stressed in each lesson. Perhaps even more flexibility can be introduced into the mechanics of the four-step method of instruction. The course is brought to an end with two or three one-man fires of good size on which everybody mops up after initial control has been achieved.

Three days are really not enough for this type of course. Four or five days would probably be sufficient but are seldom available. Nevertheless, we feel that three days of instruction as described herein buys a lot more trainee understanding than three days of classroom theory and a moderate amount of spectator training.

Every reader knows, of course, that the success or failure of the "Fire Control Practices" course rests almost entirely on the caliber of the instructor, because of the large number of critical points involved. The very nature of the course requires that one instructor and one demonstrator stay with the class for the full time. They can maintain the continuity of the course and at the same time use as valuable training aids questions and happenings that occur. Then, too, instruction will be far more effective if the teacher is able to adjust the speed of instruction to the learning capabilities of his group. Such adjustment is impossible where instructors are changed during the course.

The "Fire Control Practices" technique of instruction is hard on teachers. A great deal more time is required for adequate preparation and instruction than would be required of any instructor under the system of larger classes and divided teaching responsibility. And adequate preparation for instruction is essential. The Tahoe has discovered that a thorough field briefing and demonstration period for instructors is necessary. The thinking required in the point by point development of the course can present problems. For example, we find that instructors not thoroughly briefed in the theory of the course have difficulty in moving their groups away from a going fire to let the fire stopper move in and finish the job.

We have found that one short day is not enough for this preparatory meeting. Perhaps one long day or two short days would do the job. We think that this amount of time is justified. If the program is retained over the years and if the theory of the course is accepted throughout the ranks, perhaps such an intensive preparatory meeting will become unnecessary.

In addition to this preliminary get-together on theory and techniques, instructors must look over their demonstration area ahead of time so as to determine which spots should be used for which lessons. Considerable picking and choosing is necessary and the job cannot be done in a few minutes. Quite possibly an instructor will want to mark his planned route of travel with string, and he may even want to leave notes for himself at the many spots he has chosen for his various lessons. The string is helpful to a checker who will make a final inspection of all fires a day or two after the training session.

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Compact Cleaning Kit For Lookout Cabs

A standard ammunition box (Cal 30 M) is a very satisfactory storage container for the cleaning materials necessary for good tower-cab housekeeping (fig. 1). This 4- by 8- by 12-inch metal container, with a close sealing cover, is available at surplus stores for about 50 cents. The following items fit neatly into the box and are recommended for the essential cleaning jobs: "Squeegee" cleaner with wiping blade in combination, 6-inch width; bottle of nonflammable cleaner fluid, 8 to 10 ounces; whisk broom, 6- to 8-inch length; cellulose sponge, 4 by 6 inches; soap in tin or plastic box; 2 cleaning cloths.—**Lloyd Maki**, *Forest Fire Officer, Michigan Department of Conservation.*

VARIATIONS IN BACKFIRING IN THE SOUTH

R. J. Riebold

Forest Supervisor, South Carolina National Forests

When large-scale fire protection in the Southeast began about 1933, grass fires in 1-year roughs on cutover longleaf land were whipped out with pine tops or swatters. As fire protection succeeded, pine reproduction came in and dense stands of seedlings and saplings were formed over large areas. By 1943 the growth of reproduction had been accompanied by the growth of a dense hardwood understory and the accumulation of deep layers of pine needle fuels, often draped head high on the understory brush. Accumulation of light flash fuels alone amounted to 10 to 20 tons per acre *(4)*.[1] These conditions led to prescribed burning for fuel reduction and hardwood control *(1, 2, 7)*. In combination with other factors, they also led to the development and widespread use of the tractor-plow outfit *(5, 6)*. Standard practice today in the Coastal Plain forests is generally to stop the forward movement of the head of a fire by plowing a line in front of it, backfiring, and holding the plowed line. The control line is located far enough in advance of the fire so that the backfire and the head fire meet 25 to 50 feet from the control line. Ordinarily, little difficulty is experienced in holding the line.

When burning conditions become severe, however, surface fires burn harder and crown occasionally. Exceptionally dry conditions are sometimes coupled with erratic fire behavior. Speaking of conditions on the Francis Marion National Forest in South Carolina in 1950, Byram and Nelson *(3)* said: "It should be emphasized again that the changing fuel and stand types occurring in the Southeast may be a necessary condition for the large whirling fires which burned in South Carolina last year. These fires burned in dense stands of reproduction (predominantly loblolly pine) in which the compact crowns constituted the main source of fuel. In turn, the availability of this green fuel for combustion was increased by an unstable atmosphere plus a high rate of energy release in the ground fuels."

Under severe burning conditions the commonly used single backfire set from the control line fails in many cases to hold the head fires. The usual meeting place of head fire and backfire is too close to the control line. With backfires moving at the rate of about 1 chain per hour and head fires advancing at rates of 1 to 4 miles per hour, there is simply not time enough for the width of the burned out strip to be increased sufficiently merely by the burning of the backfire away from the control line. The need to increase this width, to place the meeting of head fire and backfire farther from the control line, has led fire control men to devise variations in backfiring practice. Those described here have been used on the Francis Marion National Forest. Probably similar variations have been developed on other fire control units throughout the South.

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[1] Italic numbers in parentheses refer to Literature Cited, p. 33.

One variation is termed "parallel backfiring." Instead of merely firing along the control line, an additional line of backfire is set between the head fire and the control line and roughly parallel to it. The first torchman works 50 to 100 feet from the control line and between it and the head fire. The second torchman fires the control line about 100 feet behind the first torchman, or close enough to keep the interior backfire from sweeping up to the control line and crossing it. Both men move in the same direction. This method puts the meeting place of head fire and backfire about twice as far from the control line as the usual practice does. It tends to reduce the heat and smoke along the control line because the two backfires draw together.

A second variation, called "delaying backfire," is similar to parallel backfiring. Its purpose is the same: to cause a crowning head fire to stop for lack of fuel at a greater and safer distance from the control line. The delaying backfire is set 5 to 20 chains from the control line instead of 50 to 100 feet as in parallel backfiring. The method of firing is the same. The control line is fired in the usual manner to hold the leeward edge of the delaying backfire, which, in the distance indicated, may acquire considerable volume and velocity.

Another variation, also intended to break the forward movement of the head of a fire, is "perpendicular backfiring." Two torchmen, 100 feet to 100 yards apart, move out from the place on the control line where the center of the head will probably hit and set backfire squarely into the wind toward the head of the fire. When they have gone as far toward the head of the fire as they safely can, they turn away from each other and return to the control line along the flanks of their backfires. The control line is fired in the ordinary manner. The two strips of backfire, advancing and spreading, break up the head of the fire at a good distance from the control line.

The movement of men setting backfires between the control line and the head of the fire is, of course, hazardous. Such work is to be undertaken only by experienced men, directed by experienced fire bosses, and supported by well-trained, well-organized crews. The woods must be fairly open and free from brush so the men can see and move. A great deal of danger is always present when men are in front of crown fires or fast moving surface fires. A crew of men strung out along a singly fired line in front of a head fire is placed in greater jeopardy than is usually realized. The burned out strip is necessarily shallow and the meeting of the backfire with the head fire may take place close to the line. The men are subjected to great heat and possibly flames. There is considerable likelihood that the woods behind them will ignite and their escape routes be closed. Backfiring methods which stop the head fire at a greater distance from the manned control line actually increase the safety of the men holding the line.

The meeting of head fire and backfire causes a tremendous updraft of heat and flame, which often result in a strip of complete kill, even when the head fire alone is not hot enough to do so. Several variations in backfiring have been employed or suggested to eliminate this belt of severe damage. The commonest is to use a road as the fireline and let the head fire come up to the road without backfiring at all. Since the clearing widths for most State, county and national-forest roads is from 30 to 80 feet, this "width of no fuel" is often sufficient. When it is not, Forester John T. Hills, Jr., who has had many years of fire suppression experience on the Francis Marion, suggests that the width of no fuel can be increased by plowing a line and burning out a 50 or 60 foot strip on the side of the road away from the fire. The added width would give the same effect as a backfire burned out 100 to 150 feet from the control line. However, the head fire would burn up to the road, instead of meeting a backfire, and, consequently, no strip of severe damage would occur.

The same result has been obtained with two plowed lines. If two tractor plows are available, paralleling lines 100 feet to 100 yards apart are plowed in front of the head fire. Instead of backfiring the inner line toward the head fire, the space between the two plowed lines is burned out in strips as in prescribed burning. The head fire burns up to the area of no fuel and stops. There is no moving backfire for it to meet and, again, no strip of complete kill occurs.

Pond pine and titi bays throughout the longleaf-loblolly pine stands create special backfiring problems. Most of the time tractor-plow outfits cannot cross the bays, and control lines must be cut around them. In dry times the bays can be plowed but backfiring in the dense undergrowth is hazardous even on the flanks and rear of a fire. Because prescribed burning for fuel reduction cannot be used in the bays, they may have a 20-year fuel accumulation. Rate of spread of the backfire may be slow and the burn-out incomplete, but a shift of the wind can cause both crew and plow to be trapped in an area of heavy brush and heavy fuel.

To deal with such a condition, Fire Control Aid James Parker used the following method. He sent the tractor-plow about 150 yards into the bay without plowing, merely breaking down brush. He then had it turn and plow out on the same line, returning to a safe place on the edge of the bay. About 100 yards of this line was backfired. When the backfire had burned out to a safe distance from the line, he sent the plow in again to repeat the maneuver. Each time, the plow returned to a safely burned out part of the line before the line ahead was backfired. The tractor-plow was thus not at any time at the end of a plow line in very thick brush while a long line of backfire was being set behind it. This method requires time and is not suited to stopping a fast-moving head fire. It does provide greater safety for men and equipment in an area of high hazard.

The successful execution of these variations in backfiring requires not only boldness and skill on the part of the men but a higher degree of organization, training, and discipline on the part of the whole attack force than is generally found in hastily mobilized crews of untrained volunteers.

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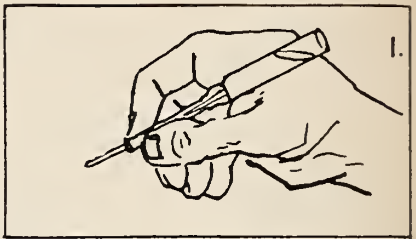

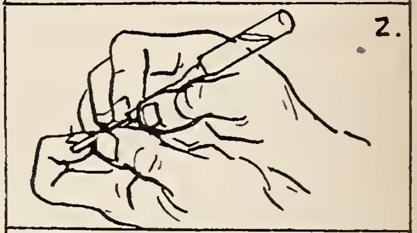

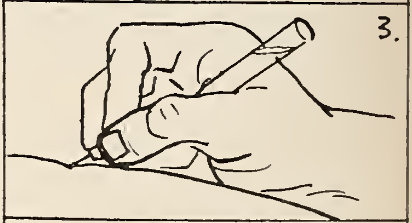

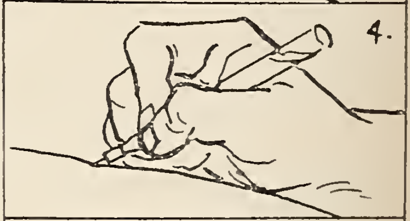

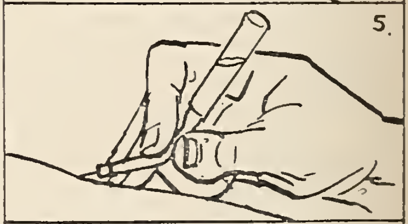

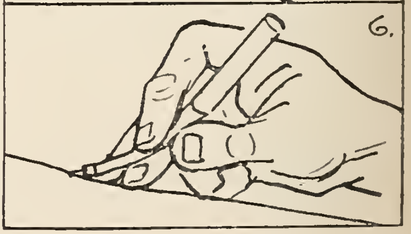

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THE IMPORTANCE OF DESIGN IN EQUIPMENT DEVELOPMENT

STEVEN SUCH

Mechanical Engineer, Michigan Forest Fire Experiment Station

The current trend toward complete mechanization has had its influence in forest fire protection as much as it has in any other field. Prior to the time of heavy-equipment application to forest fire control, only limited usage could be made of anything more effective than the simple agricultural tools. In less than a generation we have moved from shovel to bulldozer, and from buckets to large tankers and high-pressure pumps.

Behind the scenes of this mass movement to powerful machinery is the field of equipment development, made up of research, design, and manufacturing, and of continual testing and improvement. All of these are vital factors in any successful development program, and not the least of these is good design. Simply and concisely, the determinants of design are *cost*, *appearance*, *safety*, and *efficiency*. Rarely, if ever, is any one of these items the sole determinant of design. The careful designer will use all of them in guiding his work, with emphasis on an individual item if there is special need.

Americans today are becoming exceedingly cost conscious. This fact is particularly conspicuous in modern industry where the byword is "cost reduction." Automation is nothing more than rapid production with an eye to lower costs. New methods and modern contrivances for manufacturing are directly intended to mass-produce at a minimum cash outlay. The effect of cost consciousness on the designer too is marked. He can never forget that anything he designs must match the consumer's ability to pay; if it does not, it will receive a minimum of use. Such thinking is at times hard to justify from a designer's viewpoint, particularly when he is concerned with quality. Nevertheless, every effort must be made to produce the best possible product within the allowable cost bounds.

Appearance, although normally nonfunctional, must influence all design work. A general rule of thumb that any design that looks good is good, is a risky premise on which to work. A safer premise is that an attractive appearance is the basis on which a majority of manufactured articles are sold. The consumer is entitled to expect smooth and harmonious lines blended into a finished product. However, in designing it remains a matter of common sense not to give a disproportionate amount of time to appearance at the sacrifice of the other three items of cost, safety, and efficiency.

What can be said about safety that has not been said before? Seemingly very little. Absolutely nothing is more deserving of attention than any condition that can threaten the life or health of a man. Utmost care and thought must therefore be given at all times to operational safety factors and devices. It is the designer's duty and moral obligation to keep safety foremost and always in mind. Socially speaking, safety in design is probably the most important single item to be considered.

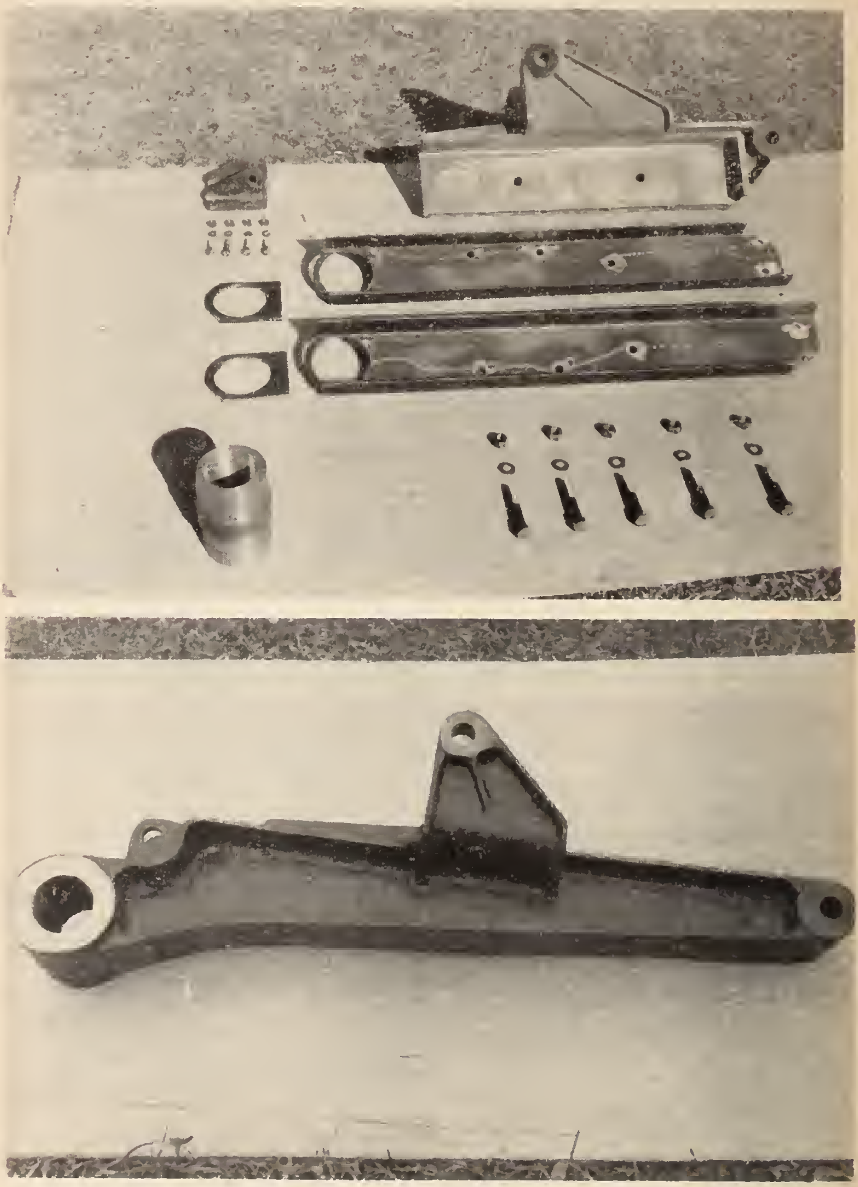

FIGURE 1.—*Top,* These 34 parts were formerly required to make up the beam portion of a hydraulically controlled plow. *Bottom,* This one casting replaces all of the parts in the top photograph. Note smooth lines and minimum machining.

The word "efficiency" in connection with the design of any one unit, as used here, covers (1) operational efficiency, (2) ease of manufacturing, and (3) the combination of multiple functions. Operational efficiency of equipment, for example, is measured by the effort required of the equipment and the excellence of execution of the given job. It is noteworthy that more often than not a high efficiency rating accompanies simplicity of design. The reason for this is beyond the scope of this article.

Where parts are to be manufactured in large quantities, ease of manufacturing is of prime importance. Very often the availability of a machine is determined by its design. In contrast with operational efficiency, ease of manufacturing is measured in terms of hours and dollars. It is therefore extremely important to keep production methods and costs as a control medium in design.

Finally, an alert designer will be constantly aware of the possibilities of combining functions and parts in the interest of efficiency. This means that sound, basic design principles of the most stable nature will be applied, not tinker's innovations.

A practical example of the application of the four determinants of design is found in a casting recently developed in Michigan for use in the production of hydraulically controlled plows. Thirty-four separate pieces were formerly required to do the job the one casting now does alone (fig. 1). The raw-material cost of the casting is approximately four-fifths of the previous cost. Manufacturing time has been reduced to about one-half. Operating efficiency has been increased at least 25 percent. All of the safety devices of the former assembly have been kept. Appearance has been noticeably improved, and at least six separate functions are being performed by the lone casting.

Design has become a significant part of equipment programs in the field of forest fire control because men with much experience in that field know that the best guarantee of strong equipment is good initial design. It is no accident that the steady decrease in acreage lost per fire in Michigan is accompanied by a better and better fleet of fire fighting equipment. Good initial design of equipment will continue to be sought after as one means of fast and effctive control of forest fires.

MARKINGS FOR IDENTIFICATION OF FIRE CONTROL VEHICLES FROM THE AIR

Samuel S. Cobb
District Forester, Pennsylvania Department of Forests and Waters

The rapidly increasing use of aircraft in fire control work during recent years has raised many problems for forestry officials in supervisory positions. The Wyoming Forest District, one of the twenty administrative units of the Pennsylvania Department of Forests and Waters, has been no exception. This district includes, as about one-third of its area, the northern edge of the anthracite coal fields. Once the forest fire hot spot of the State, the section has cooled decidedly over the past 15 years, but because of its high percentage of forested lands, numerous hazards, and flashy fuel types, it is still a fire problem of considerable scope. As a result, the use of aircraft in the district has become greater with each passing year. Planes are used for detection, scouting, and directing ground crews.

One of the major problems has been the identification, by pilot or observer, of ground vehicles of the supervisory personnel of the district. These include those of foresters, fire inspectors, forest rangers, and smokechaser teams. Until the past year, practically all department vehicles were standard model trucks and cars. In the main, fire inspectors and smokechaser teams are assigned ½- and ¾-ton pickup trucks. Rangers use ½-ton pickups and have light dump trucks which are occasionally used for fire work. The foresters drive pickups and standard sedans. Unless these vehicles have special fire fighting rigs such as tanks, live reels, or side racks holding spray tanks, they are indistinguishable from hundreds of similar vehicles when viewed from the air. Many of the fire wardens dispatched to a fire also drive light trucks. Before air to ground radio became available, message-drop tubes were often thrown to crew units distant from the supervisory officer on the fire. In many cases the information dropped never reached the fire boss.

Inspector Robert J. Startzel at the Hazleton Station decided to mark each of his trucks with two white bars about 8 inches wide and at least 4 feet long, parrallel to each other and extending from the front to rear of the truck cab (fig. 1). This marking was soon applied to the fire vehicles throughout the district. When the two aircraft in use were equipped with radios capable of communicating with the tower sets, vehicle mobile units and field portables, the problem of identifying supervisory vehicles became twofold. The primary concern was for the pilot to recognize radio-equipped vehicles to which direct voice contact could be established. The secondary concern was recognition of super-

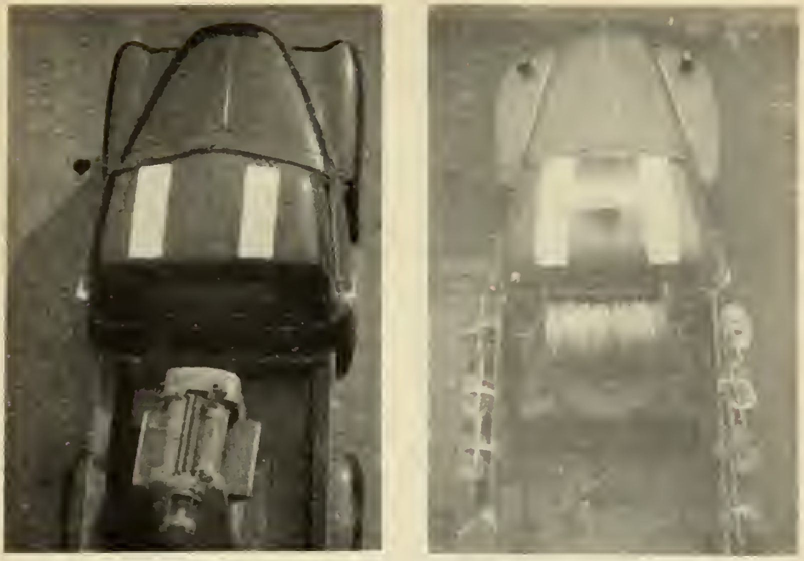

FIGURE 1.—*Left*, Marking originally used to identify all district vehicles. Now used to identify all vehicles not equipped with shortwave radio. *Right*, All district vehicles marked with the crossbar are equipped with shortwave radio.

visory vehicles, not radio equipped, that required use of drop tubes. This latter class was significant in that the vehicles of park and forest rangers in the north end of the district were not radio equipped.

To solve this problem, all radio-equipped vehicles now have a white crossbar painted between the parrallel bars, forming a large H on top of the cab. All district vehicles regardless of their primary work function now carry either the parallel bars or the large H.

During the severe summer fire seasons of 1954 and 1955 and the hazardous spring season of 1955, the pilots of the aircraft and the forestry personnel who often flew with them to direct control activities found these simple markings made it possible for them to identify key vehicles rapidly. It also speeded establishment of contact with the ground forces, especially by radio.

INTEGRATING PREVENTION INTO FIRE CONTROL PLANNING

CRAIG C. CHANDLER

Forester, California Forest and Range Experiment Station[1]

Historically, fire control planning has been concerned primarily with the job of detecting and extinguishing fires; little effort has been made to coordinate fire prevention activities with suppression and presuppression work. But history is a record of change, and now is the time to progress beyond the familiar pattern of fire control planning.

Why has prevention been subordinated or excluded from planning? One reason is that early fire control objectives were based upon the need to keep the total area burned annually within a given percentage of the total area protected. Show and Kotok established that the total area burned was closely correlated with the percentage of fires exceeding 10 acres.[2] They concluded that the area burned could be reduced to an acceptable amount only by prompt, effective attack aimed at extinguishing all fires in their initial stages. Under this concept the number of fire starts is relatively unimportant—providing all fires are quickly controlled.

There are two additional reasons why prevention has not been emphasized in fire control planning. First, planning is usually done on actuarial principles, that is, plans are based on past experience. Therefore, in the planning analyses fire occurrence is considered either as a constant or as having a constant trend.[3] Second, transportation and communication facilities have only recently advanced to the point where prevention and suppression activities could reasonably be undertaken by the same personnel during the fire season.

As a consequence, neither the official Forest Service fire control policy (10:00 a. m. control) nor Hornby's principles of fire control planning[4] provide for fire prevention as an intergrated fire control activity.

This is not to say that fire prevention has been ignored or ineffective. Far from it; the national forests in California had 19 percent less man-caused fires per thousand acres in 1950-54 than in 1930-34, and 25 percent less area was burned per thousand acres by man-caused fires. During the same period, the *percentage* of fires exceeding 10 acres remained almost constant, while the *number* of class C fires decreased in approximately the same proportion as the total number of fires. From the record it would appear that fire prevention efforts have been as effective as, if not more effective than, increased presuppression and suppression activities in reducing the area burned on the national forests of California. A stepped-up prevention program which would bring about a further decrease in the number of fires started should pay off equally well in reducing the area burned and the consequent damage to natural resources.

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[1] Maintained at Berkeley, Calif., by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of California.

[2] SHOW, S. B., and KOTOK, E. I. THE DETERMINATION OF HOUR CONTROL FOR ADEQUATE FIRE PROTECTION IN THE MAJOR COVER TYPES OF THE CALIFORNIA PINE REGION. U. S. Dept. Agr. Tech. Bul. 209, 46 pp., illus. 1930.

[3] HORNBY, L. G. FIRE CONTROL PLANNING IN THE NORTHERN ROCKY MOUNTAIN REGION. North. Rocky Mtn. Forest and Range Expt. Sta. Prog. Rpt. 1, 179 pp., illus. 1936.

[4] GISBORNE, H. T. HORNBY'S PRINCIPLES OF FIRE CONTROL PLANNING. Jour. Forestry 37: 292-296. 1939.

To insure that fire prevention plays its most productive role, it must be integrated with the planning and normal operation of the fire control team. Stathem[5] summed up this reasoning in the phrase "A prefire rather than a presuppression organization." To meet the requirements of a prefire organization, principles of fire control planning should be developed which recognize the prevention job as being basic to successful fire control. Once fire control agencies are organized for prevention, they may achieve results far beyond any established goals.

Organizing around fire prevention need not sacrifice the tested standards of initial attack time and strength. Actually some California national forests as well as some State and county units are modifying fire control plans to emphasize prevention. Many standby fire suppression crews have been converted to roving prevention-firemen. They perform prevention jobs while maintaining the same, or improved, standards of initial attack. However, to achieve maximum benefits from a reorganized fire control plan, it will be necessary to do more than merely shift functional responsibilities from one group to another. If fire prevention is to be integrated into fire control planning, a major reevaluation of planning methods is needed.

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[5] STATHEM, P. A "PREFIRE" RATHER THAN A "PRESUPPRESSION" ORGANIZATION. Fire Control Notes 15 (4): 32-37. 1954.

DEN TREE FIRES IN MISSOURI

Osal B. Capps
District Forester, Missouri Conservation Commission

Smoking squirrels out of den trees is an old Ozark custom. Hill people, in general, see nothing wrong with this method of securing "meat for the table" until they realize that more than a game law violation is involved. Some see fire burn their property; others see damage to someone else's property; some realize that many squirrels either burn in the blazing dens or escape. Then, too, the news spreads quickly when someone is convicted in court for causing forest fires.

Fires caused by burning den trees occur more often near population centers and are usually started by urban people who were born and reared in rural areas. Methods used to smoke out squirrels include placing a lighted railroad fusee, igniting dry leaves, or setting fire to gasoline in the base of a hollow tree.

Den tree fires are more of a nuisance to fire control personnel from an acreage-burned viewpoint than a serious threat. They are potentially dangerous, however, in areas where tower coverage is poor. State organizations interested in hunter-landowner relationships also must consider the "No Hunting" signs that are often posted on private land after this type of fire has aroused the anger of the owner toward hunters in general.

The Gasconade District of the Forestry Division, Missouri Conservation Commission, comprises almost 2 million acres of privately owned land. The district is about 66 percent forested and Fort Leonard Wood, Rolla, and several smaller towns are included in its area. Hunters from St. Louis, Jefferson City, and, to a much lesser degree, Kansas City, hunt in the district. Den tree fires were given little consideration until the serious drought years of 1952, 1953, and 1954. In normal years many squirrels are probably smoked out of den trees without the trees catching fire, or, if the trees do burn, without starting active forest fires. During the drought years practically all smoking-out attempts started fires in den trees and these in turn caused active forest fires.

Plans were made in late 1952 to investigate all fires more thoroughly in an effort to separate den tree fires from debris burning fires. Fire prevention activities, including law enforcement, were pointed at den tree fires. Newspaper and radio publicity was given to the number of fires, the damage caused, and the penalties imposed on persons convicted in court for starting such fires. An "Every Sportsman a Fire-fighter" project was highly publicized on a statewide basis to educate the sportsman and to enlist his help in preventing and suppressing fires.

On the Gasconade District in 1953, 70 fires (17 percent of all fires) were definitely started by hunters attempting to smoke squirrels out of den trees. These fires burned 457 acres and accounted for 9.5 percent of all acreage burned. All of these fires were investigated to determine where and how they started. Evidence, such as empty shotgun shells near the den tree, was sought and an attempt was made to find out who was hunting in the area at the time each fire started. Such facts are difficult to determine because several hours may elapse before the smoldering fire builds up enough to be seen from towers or aircraft.

As a result seven individuals were convicted in court for "molesting den trees by setting fire to trees" or for "negligently causing woods to burn by setting fire to trees." No cases were lost and fines ranged from $1 and court costs to $50 and costs. Court costs ran about $8.50. The average fine was $25.14. Where evidence insufficient to prosecute was secured, persons who had started fires were contacted and warned.

On the Gasconade District in 1954, 47 fires that started from burning den trees burned 155 acres. This was 16 percent of all fires and 4.9 percent of all acreage burned. Six persons were convicted in court for this type of fire law violation. The average fine was $8.50 and court costs again ran about $8.50 per conviction. One man was sentenced to 90 days in jail with the sentence stayed upon good behavior.

Den tree fires will continue to be a nuisance on this district for several years and will be particularly troublesome in drought years. This type of fire will have to be expected and planned for at all times but should decrease in occurrence in proportion to the effort spent in educational activities and law enforcement. Rural residents who smoke out squirrels in normal years become aware of the danger in drought years and are much more careful than their city cousins who frequently have no interest other than "getting meat for the table" or a lot of squirrels to brag about when they go home.

The city man who wants a place to hunt in the future should take heed—the farmer will not tolerate hunters who damage his property. The small fire, while only a nuisance to fire control personnel, may damage some of the best trees a farmer owns. Good sized trees are frequently killed by late spring and early fall fires. Many city hunters will get blamed and penalized for every indifferent hunter who smokes out a squirrel.

SPRAY PLANE CHECKS FIRE

DIVISION OF FIRE CONTROL
Region 6, U. S. Forest Service

Through the years there have been a number of methods in which aircraft have water bombed or applied water to ground fires. As far as we know, the spray-plane method of application described herein is a "first." Two important points need to be understood in connection with the operation: pilot skill, and fuel type.

Pilot Skill:—Crop-dusting spray pilots are skilled pilots. They know their planes and just what can be expected of them. They understand low-level downdrafts and cross winds. No other pilot spends as many hours flying at treetop heights.

Fuel Type:—The fuel type in this fire was cheatgrass. Cheatgrass is a thin-stemmed annual now present to a greater or lesser extent in all the western States except Arizona and New Mexico. When cured, cheatgrass is very flammable. Cheatgrass fires, especially when occurring on steep slopes or when wind-driven, are fast spreading. Except for their fast spread, they are are easy to control. Because of the fineness of the stems, cheatgrass fires frequently go out by themselves in the late evening with the rising of the humidity. A very minor amount of spray will bring about control.

During the winter of 1955 the Wenatchee Air Service of Wenatchee, Wash., suggested to Fire Staff Officer Bob Beeman, of the Wenatchee National Forest, that a spray plane might be of value in checking the head of a fast-spreading fire in fuels of the type described. Beeman agreed.

On July 23 a dry lightning storm set a fire on the slope of the Wenatchee River canyon near Cashmere, Wash. The fuel type was cheatgrass with scattered sagebrush. The slope was steep. Here was the chance for a test. The plane used was a 135 horsepower super cub equipped with a 100-gallon tank. The plane had, mounted on its wings, twelve ¼-inch nozzles, six to the side, with a shut-off control from the cockpit.

Pilot Carey made 2 runs across the head of the fire, flying with 1 wingtip at the fire's edge, 10 to 15 feet above the ground. The water spread was approximately 33 feet, the air resistance breaking the water up into a fine spray. The runs were made on the uphill side of the fire on the wind side. Water discharge was 1-½ gallons per second and the plane carried enough water for 60 seconds of application. One-quarter mile of fire front was covered at each run.

This trial proved the effectiveness of the spray in checking the head of the fire and gave the ground crew time to control the flanks without difficulty. The fire was controlled at 55 acres.

In reporting this experiment, Supervisor Blair said, "On being advised by Pilot Carey that he had flown 10 to 15 feet above the ground, I felt that this distance was too close for safety and the possibilities of the plane being caught in a downdraft were too great to permit a continuation of this practice. I am, however, of the opinion that the use of spray planes on fires of certain types has possibilities but more thought needs to be put into the risks involved."

The Wenatchee Air Service suggests that a plane of greater horsepower be used, such as a Stearman with a 450-hp. engine and 150-gallon water tank.

Supervisor Blair commented, "On this particular trial no wetting agent was used in the water."

It is not likely that a wetting agent would have been of any advantage. There is no evidence that it increases the extinguishing power of water on an extremely fine fuel such as cheatgrass. Its value is in deep-seated fuels where penetration is desirable. However, a fire retardant certainly may have possibilities in fires such as this. When a retardant is used it makes no difference if the fine spray does dry out in advance of the fire reaching the line. The salt deposits on the fine fuel will still stop the fire under many situations.

A progress report on Operation Firestop states: "It appears that chemical fire lines may be put in by aerial application." A Sikorsky S-55 helicopter, as was used in the California tests, might well be the answer. Military cooperation, however, would be necessary.

In the fall of 1947 a wild burning prairie fire spread over 380,000 acres of South Dakota farm and grass lands in 2 days. Losses were in excess of 2 million dollars. Much of the fire line, in situations like this, could be "laid down" from the air. Canvas tanks, similar to Harodikes, could be made to fit into the larger helicopters; spray booms could be attached. This would cost money, but so does a 2-million-dollar fire.

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Published Material of Interest to Fire Control Men

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CANVAS WATER SHOW

A. B. Everts
Equipment Engineer, Division of Fire Control, Region 6,
U. S. Forest Service

A big tank truck, with water capacity of 500 to 1,500 gallons or even more, roaring up to a hard-to-hold sector of fireline causes the pulse to quicken. It's like the feeling, akin to jubilation, experienced by an exhausted, hard-pressed line construction crew when a snorting bulldozer comes crashing through the brush. This is help, real help, when it's needed most.

However, big tankers cost money. There are never enough of them. Frequently there aren't any at all. Does this mean that the use of water on holding, control, and mopup need be abandoned? Not necessarily. Here is an opportunity to put in a canvas "show"—provided you have the gear, and you can buy a lot of gear for the cost of one 300-gallon tanker.

Admittedly, tankers give you a maneuverability not possible with a canvas show. In that respect they are superior. If you can't have the best you will have to settle for less, and second best might very well be a canvas show—unless, of course, the available water is such that you can operate a pumper or gravity show. A canvas show need not necessarily be fixed or immobile, as we shall see.

In addition to hose (which might be considered canvas), nozzles, and in many situations pumps, a canvas show layout may utilize any or all of the following gear: Storage tank, gravity sock, relay tank, transporting tanks. This equipment permits a wide range of combinations in various water show setups.

Storage tank.—A new production item manufactured by a Midwest firm is a lightweight, folding, portable 1,000-gallon tank (figs. 1 and 2). The tank is 8 feet 3 inches square and 30 inches

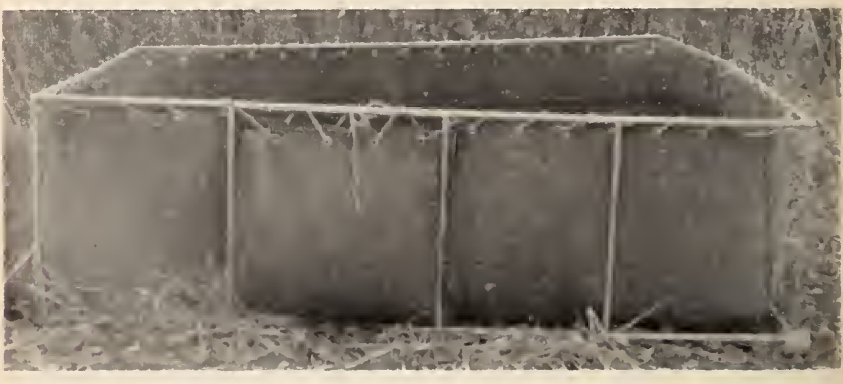

Figure 1.—1,000-gallon storage tank set up for use. The bulge in the second section from the left is the spillway. This section can be unlashed and lowered for quick emptying of the tank. In some tanks, it may be worthwhile to install a collar with a 1½-inch discharge port and cap near the bottom to permit the use of a gravity line instead of a siphon.

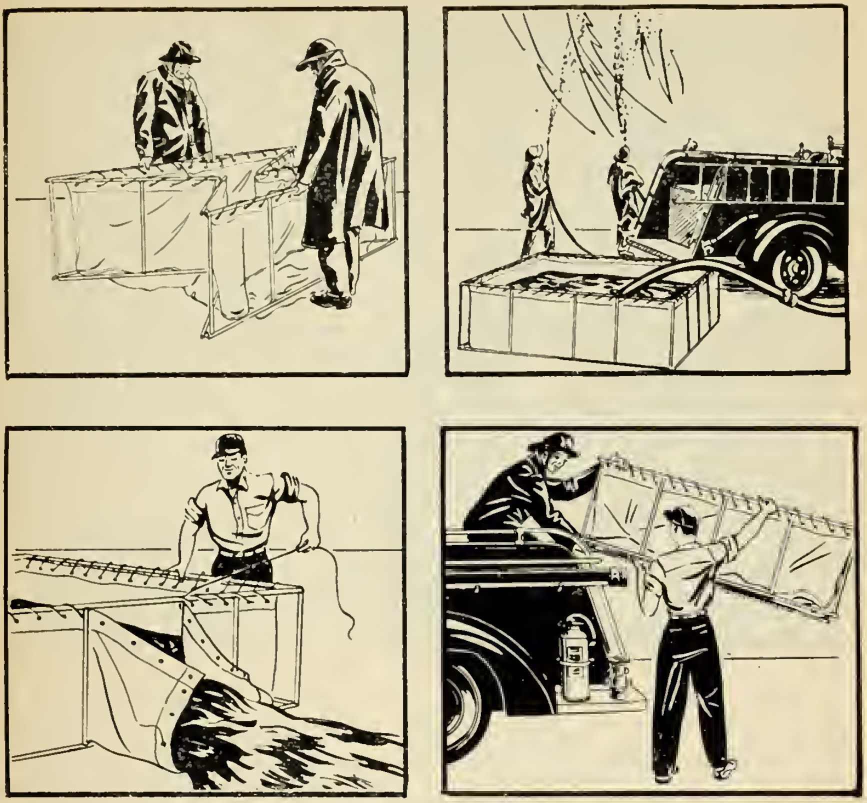

FIGURE 2.—1,000-gallon storage tank.

high; when folded it takes a space 8 feet 3 inches long, 30 inches high, and 10 inches wide. The frame is made of ¾-inch O.D. tubular steel, with welded joints and hinges. Liner material is No. 10 waterproof duck, mildew treated and vermin resistant; bottom and side seams are overlapped and double sewn. The canvas liner has grommeted holes to receive the heavy-duty, long-strand cotton, braided rope lashings. The tank weights 119 pounds and costs $179.50 f. o. b. the factory.

There is some seepage from the tank. The manufacturer states that it amounts to 20-25 gallons in the first 4 hours. Then the seepage gradually diminishes until, after 24 hours, it has practically ceased.

Gravity sock.—Gravity socks or intakes have been in use for years (fig. 3). They are included here, because there are many places where they can be used to fill the 1,000-gallon storage tanks. Tiny rivulets may not sustain a continued pumping operation, but the collection of this water into a storage tank will permit at least intermittent pumping or gravity use. Several intakes to collect ground seepage, such as occurs around springs, may even provide sufficient water for continuous use.

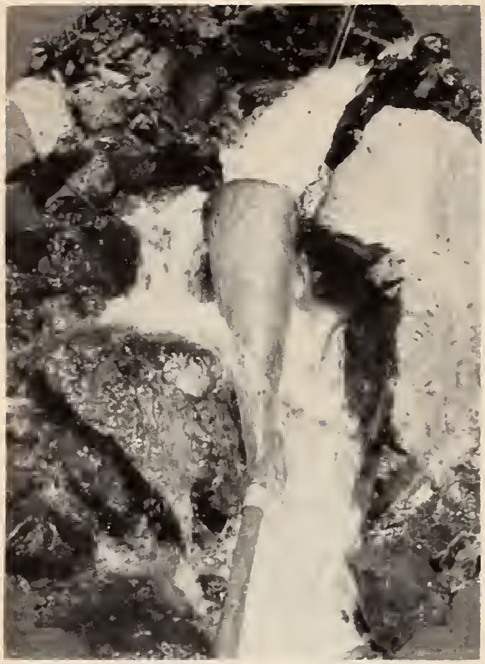

FIGURE 3.—Gravity intake set up for a gravity line. This water supply is sufficient for continuous use without a storage tank. There may be occasions, however, when bringing the water into a tank on a road will provide adequate water for several tank trucks.

Relay tank.—The primary purpose of a relay tank is to boost water to a fire at a higher elevation than could be reached by one pump alone. The usual method is to set up a pump at the water source and pump water into a canvas relay tank some 250-300 feet vertical distance above. At this point, a second pump is used to boost the water up the next leg of the relay, or to the fire, as the case may be. Relay tanks may fit very well into the overall canvas show, to bring water to a tanker filling point, direct to the fire, or to fill the storage tanks for either gravity or pumper operations.

A typical relay tank has a capacity of about 75 gallons. The canvas is treated, mildewproof duck, reinforced at all points of stress.

Transporting tanks.—This term is used to describe the self-supporting pyramidal tank (fig. 4). Since they are completely enclosed, they are ideal for transporting water in pickups, dump or stake trucks, or most any other type of vehicle. Available in 2 sizes, 150- and 300-gallon, they can be used to haul water to a 1,000-gallon storage tank. The 300-gallon size weighs only 24 pounds empty, and 2 of this size will fit easily on a 1½-ton truck. Present cost of the pyramidal tanks is $99 for 300-gallon and $83.50 for 150-gallon size, f. o. b. the eastern factory. They are mildew treated.

The Pacific Northwest region of the Forest Service has many opportunities to use canvas advantageously, especially in connection with fall slash burning. In calendar year 1954, 2½ billion board-feet of timber valued at more than 34 million dollars was

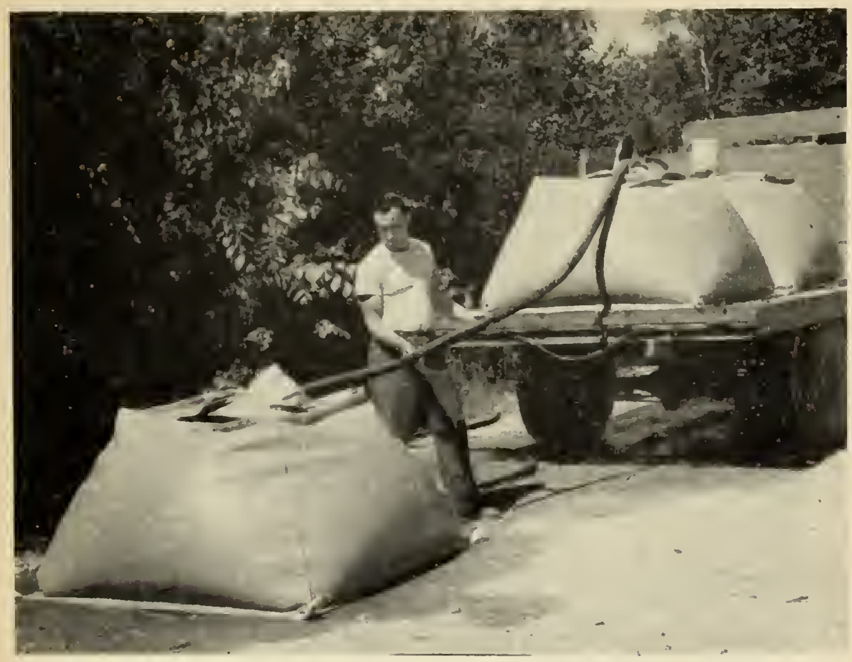

FIGURE 4.—Siphoning water into a pyramidal tank for storage.

cut on the national forests in the region. A volume of cut such as this produces a large and sometimes complex slash disposal problem. The time during which broadcast burning can be done is limited by weather conditions, but unlike the "regular season" fire, there is time for sizeup and advance planning.

Broadcast burning of slash offers an excellent opportunity to study fire behavior, and many of our men are becoming quite adept at recognizing possible trouble spots. More and more water shows are being laid out in advance to handle these expected critical areas.

The region has an average of 1.7 small slipon tankers per ranger district. The pumps on these slipons can be quickly removed and used in the same manner as portable pumpers. In addition there is an average of 1.5 portable pumps per district.

Access to the slash areas is no problem, and many of the cutting areas are on steep ground where gravity systems are a "natural." The 1,000-gallon storage tanks can be quickly moved from one cutting area to another. Any water-carrying vehicle can be used as a nurse tanker to keep them filled, and they in turn are a source for filling the small slipon tankers or for pump or gravity shows. These tanks are a welcome addition to our equipment.

FIRES ARE SMALLER ON THE APALACHICOLA RANGER DISTRICT

H. R. RAUM[1]

District Ranger, Florida National Forests

The total number of fires, most of them caused by lightning, has not substantially decreased since 1939 on the Apalachicola Ranger District. However, a greater percentage of these fires is confined to smaller size classes. A definite increase in percent of Class A and Class B fires is accompanied by a noticeable reduction in percent of Class C fires and a minor reduction in Class D and E (fig. 1). While this chart is not meant to represent regular and steady yearly progress in controlling fires when they are small, it does show the trend toward this goal over the 15-year period 1939-53. Protected national-forest acreage lost to wildfire annually has decreased from one-third of one percent during 1939-43 to one-fifth of one percent during 1949-53.

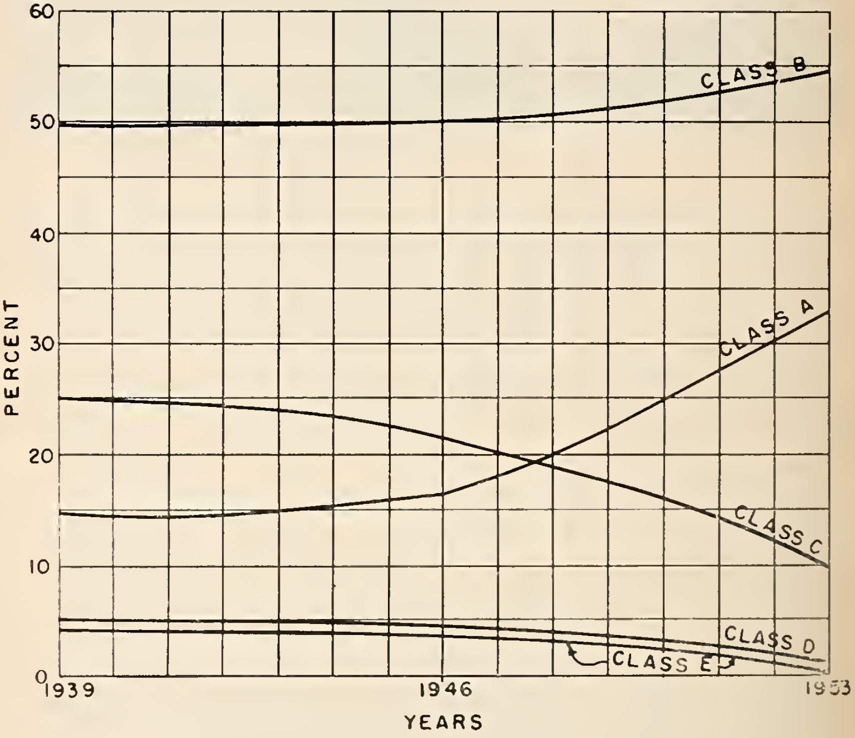

FIGURE 1.—Trend in percent of fires on the Apalachicola Ranger District by size classes, 1939-54.

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[1] Now on the Supervisor's staff, North Carolina National Forests, Asheville, N. C.

Several factors have contributed to this trend. The increased use of mechanized equipment to replace manpower since the close of the CCC period is probably the most important. The chart indicates the beginning of the trend to smaller fires at about this same time. The Apalachicola Ranger District is equipped with heavy-duty tractors and plow units of the TD-9 Mathis type transported on 2½-ton tandem-drive trucks. Travel time to fires has been materially reduced by the change from semitrailer units to the present tandem-drive vehicles. The replacement of manually operated plows with hydraulic units and the development and use of tanker equipment has reduced fire control time. These factors have resulted in a corresponding reduction in area burned.

State highway construction in this district, together with construction and improvement of U. S. Forest Service roads, has speeded up control action, especially in the southern part of the district. In some areas travel time has been cut by two-thirds because of improved roads.

A carefully planned prescribed burning program, designed to form patterned barriers against large fires, has played an important role in the task of keeping down the size of wildfires. Prescribed burning was started in 1943 on this district; now about 20 percent of the net burnable acreage is prescribe burned annually.

We are compelled to depend almost entirely upon U. S. Forest Service crews for suppression action. There are no sources from which to obtain large crews of fire fighters within reasonable time limits. The fact that fast spreading fires in flash fuels can start within a few hours after a rain, together with yearlong fire occurrence, requires that we apply all available means of controlling fires while they are small.

INEXPENSIVE ELECTRIC STARTER FOR PORTABLE PUMP ENGINES

MELVIN A. FREYTAG
District Forester, Ohio Division of Forestry

The starting device described here was designed and built by fire control personnel of the Ohio Division of Forestry, New Philadelphia, Ohio, at a cost of $28.43 for materials. It was designed to remedy engine starting difficulties experienced with a new truck-mounted portable pump. This starter has now undergone sufficient testing to assert that it efficiently fulfills its purpose.

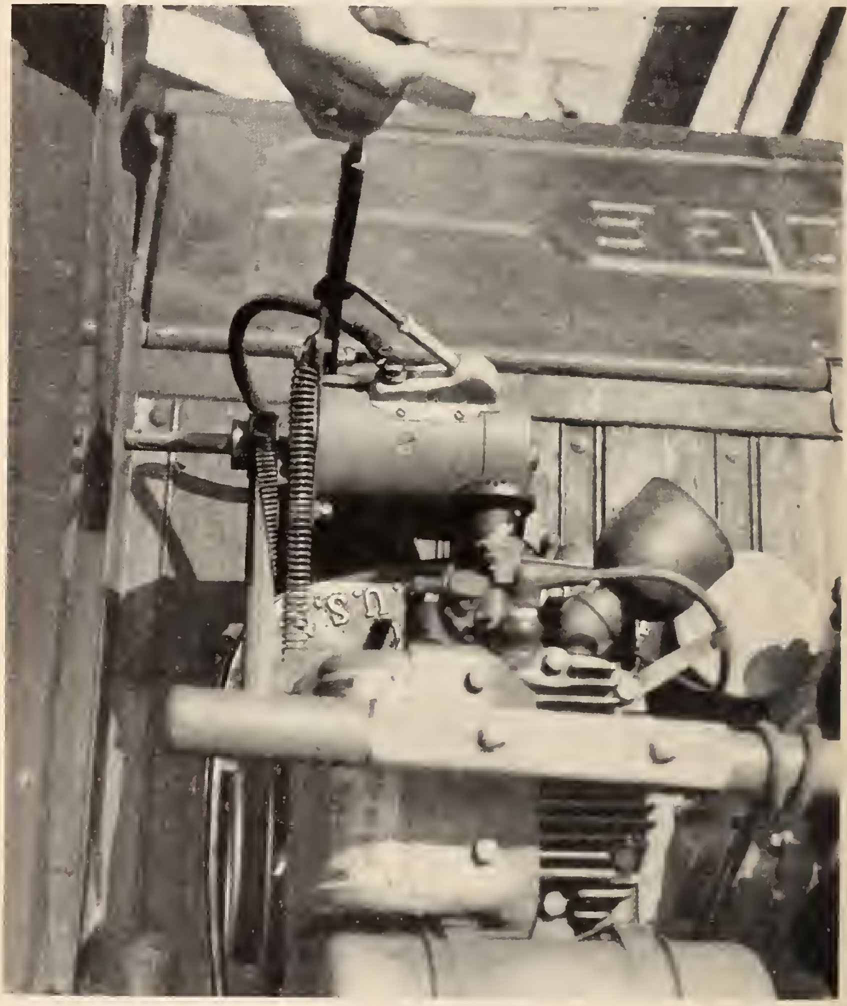

FIGURE 1.—Pulling the starter handle tightens drive belt; moving it toward switch will close contact and start motor.

The principal part is a rebuilt, 6-volt automobile starter motor that is powered through cable connection to the truck storage battery. Power is transmitted by a V-belt from a 2-inch V-pulley on the starter to a 5-inch V-pulley mounted on the pump engine. The starter, which is hinge mounted, is held in a nonoperating position by a coil spring. A handle is mounted on the starter swinging it away from the pump motor and so placing tension on the drive belt. Side motion of the handle permits activating the starter at the same time tension is applied (fig 1).

To operate starter, pull handle until sufficient tension is applied on the drive belt to transmit the power. Then, move handle sideways toward switch to close the contact and start motor. When pump engine starts, release tension on starter handle so coil spring can return starter to a forward, nonfunctioning position. Remove drive belt from rotating engine pulley to prevent wear.

The starter can be detached easily from its base to permit removal of the pump. The pump engine can be started in the field by use of a standby starter rope.

☆ ☆ ☆

Oil Drum for Parachuting Portable Pumper

Parachuting pumper equipment to fire fighting crews in the back country may spell the difference between a fire getting away or being controlled while small. A 35-gallon oil drum container has been used successfully to protect a portable pumper dropped by parachute.

The top of the drum is cut out and the pumper, mounted on a metal pack frame, is bolted by four wing nuts to the inside of the drum near the top. The pumper is suspended approximately 4 inches off the bottom. Four rings are bolted to drum near the top for fastening the parachute. The container is disposable. Total weight of container and pack frame is about 37 pounds, with "Y" pumper, 107 pounds.

When the smaller 38-pound pumper unit is used, in addition to the pumper and metal pack frame, the container holds an accessory kit, 1 gallon of gas, and 500 feet of 1-inch linen hose. The 5 rolls of hose are placed in the bottom of the container; then the pumper is placed in position and bolted in. The gas and accessories are placed on top of hose and the unit is ready. The complete outfit, including container, weighs 156 pounds.—LOUIS F. DEYAK, *Fire Control Aid, Superior National Forest.*

METAL PACK FRAMES FOR PORTABLE PUMPERS AND POWER SAWS

Louis F. Deyak

Fire Control Aid, Superior National Forest

Pack frames are often necessary for carrying portable pumpers and power saws. The familiar wooden pack frame served the purpose, but had the disadvantage of excessive weight, joints became loose after limited use, wood became oil soaked, and the frame was hard to construct. A wooden frame sturdy enough to stand the wear was too large and cumbersome.

A metal pack frame with welded joints, which eliminates all of the above disadvantages, can be easily constructed from ½-inch thin wall conduit (fig. 1). It weighs half that of the wooden frame and costs about $12.

These materials are needed:

1 10-foot length of ½-inch thin wall conduit.
6 ¾-inch harness rings.
4 ¾-inch harness buckles.
4 3/16- by 2½-inch stove bolts with wing nuts.
1 4-foot length of ¾-inch leather strapping.
1 14-foot length of condemned 1½-inch linen fire hose.
2 webbed shoulder straps (as used on fire backpack pumps).

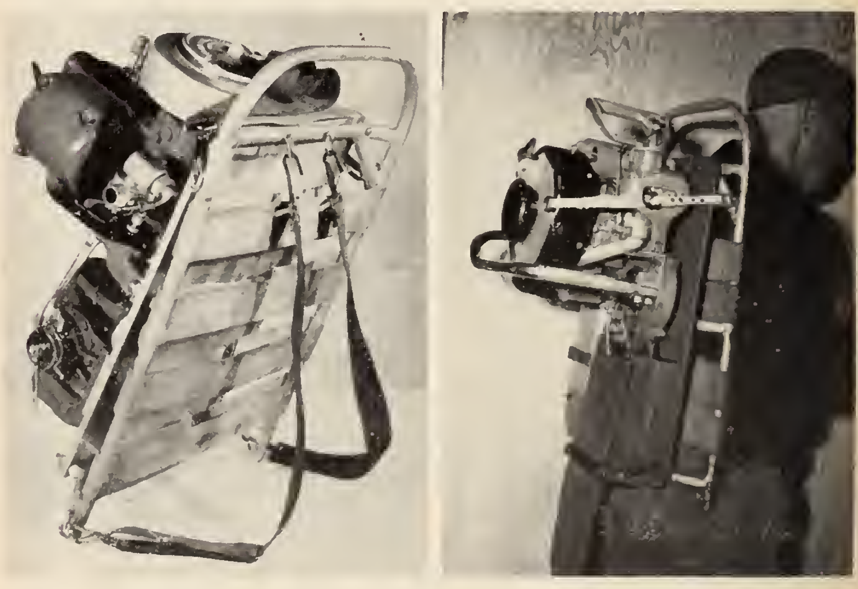

FIGURE 1.—Metal pack frame: *Left*, portable pumper bolted down; *right*, power saw in place. The four lengths of 1½-inch linen fire hose are pulled tight by means of ¾-inch harness buckles and leather strapping riveted to the ends.

A portable pumper with accessory kit and suction hose can be mounted as a compact unit weighing 64 pounds on the metal pack frame. The 1-inch suction hose is wrapped around the pumper and tied.

The mounted saw is a complete unit weighing 50 pounds. The accessory box is made as part of the pack frame and contains an extra saw blade, pliers, 6-inch screwdriver, 8-inch adjustable wrench, 5/8-inch socket wrench, spark plug wrench, one connecting link and rivet assembly, extra spark plugs, a few extra cutters and rakers, quart of oil for oil reservoir, and notebook and pencil. The saw is very easily dismounted from the pack frame by loosening 2 wing nuts which hold the beaver tail in place, loosening the strap which holds the saw to the pack frame, and lifting up.

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Rear-Step Push Button for Enclosed Cab Fire Trucks

Safety is a major concern of every fire chief. Here is one device that has paid dividends in added safety. Push buttons have been installed on nearly all the fire trucks of the Central Rhode Island Firemen's League. The button is within easy reach of the rear-step riders and activates a bell or buzzer in the driver's cab. A code is used to transmit emergency instructions to the driver.

This system of communication, long in use between tillermen and drivers of aerial-ladder trucks, was adopted by the West Greenwich Fire Department after a disastrous incident last year. Working close to the flames of a forest fire, one of the riders on the rear step had the misfortune to have his shirt catch fire. The flames, fanned by wind created by the truck's passage down the road, engulfed the unfortunate fireman. The other rear-step riders shouted to the driver to stop, but they could not be heard. The flaming man was forced to jump from the rear step. He was followed by two fellow firemen who promptly extinguished the flames. However, the burns suffered by this fireman were so serious that he was hospitalized for a long period.

The Hopkin's Hill Fire Department, on learning of the emergency communication installations on the West Greenwich Fire Department trucks, adopted the device for their own trucks. Shortly after rear-step push buttons had been installed, a dramatic proof of their usefulness was enacted.

While answering an alarm at 45 m. p. h. one of the fire trucks lost a tie-rod! A fireman, following in his own automobile, saw the tie-rod fall off. Quickly breasting the rear-step riders, he told them what had happened and to slow the racing fire truck gradually to a halt "so they wouldn't fetch up in a heap!"

Using the buzzer code, the rear-step riders instructed the driver to bring the truck slowly to a halt. Whereupon the driver jumped to the ground, demanding angrily to know what in blazes they thought they were doing! They pointed to the tie-rod being brought up by the fireman in the automobile and suggested it be put back on the truck before going any farther. This rear-step push button for emergency communication is a safety device of wide usefulness.—ANNE C. HOLST, *Cedar Hill Forest Fire Experiment Station, Cedar Hill Fire Department, Cowesett, R. I.*

AIR DELIVERY OF WATER HELPS CONTROL BRUSH AND GRASS FIRES[1]

JOSEPH B. ELY, *Fire Control Officer, Mendocino National Forest,*
and ARTHUR W. JENSEN, *Forester, Division of Forest Fire Research, California Forest and Range Experiment Station*

Dropping water or fire-retardant chemicals from low-flying aircraft can help ground forces control brush and grass fires. That such water drops are practicable has been demonstrated by a recent series of field trials and calibration tests conducted by the Mendocino National Forest and the California Forest and Range Experiment Station in cooperation with the Willows Flying Service, the California Division of Forestry, and the Arcadia Equipment Development Center. As much as 120 gallons of water at a time was carried to fires in an airplane normally used for crop dusting and other agricultural purposes. Water dropped through a single outlet designed by the Willows Flying Service proved effective in quieting hot spots on large fires and in retarding spread of small fires in brush and grass.

Previous studies have established several guidelines for dropping water from aircraft: (1) The danger to men, equipment, and buildings prohibits the use of missiles or droppable containers—in fact, any projectile—in populated areas or as close support to fire fighters on the ground. (2) Aircraft must be maneuverable and have a considerable reserve of power. (3) Pilots should be capable of flying close to rough topography and of achieving pinpoint accuracy with safety. (4) Water dropped free-fall reaches the ground and has a significant effect on some fires.

In consideration of these guidelines, it was decided to test the adaptability of an agricultural aircraft as an aerial tanker, and to attempt drops of uncontained water on fires.

At the suggestion of the fire control staff of the Mendocino National Forest, the Willows Flying Service adapted a 450-horsepower biplane used in agricultural work for trial as an aerial tanker. The spray equipment connected to the 160-gallon tank in the fuselage was removed and a single outlet was installed at the base of the tank.

The outlet measures 7 by 18 inches and is constructed of heavy sheet metal. The outlet gate is hinged at the front and has a rubber gasket to insure watertight seal. At first, when the gate was opened by tripping a simple latch from the cockpit, the sudden release of water caused the plane to jump about 100 feet and the pilot to black out temporarily. This difficulty was corrected by equipping the outlet gate with a controlling lever which permitted the pilot to open the gate more slowly in all subsequent tests.

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[1] Reprinted in part from "Air Delivery of Water Helps Control Brush and Grass Fires," by Joseph B. Ely and Arthur W. Jensen. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. Forest Res. Note 99, 12 pp., illus. 1955.

Preliminary trials conducted in early August 1955 over flat ground at an airport showed that water could be dropped successfully. In the first trial, 120 gallons of water was dropped from an elevation of 30 feet at an airspeed of 80 miles per hour. The water from this drop covered an area approximately 30 feet wide and 285 feet long. A test fire in grass, 20 feet wide and 600 feet long, required three 120-gallon loads of water and 10 minutes of follow-up work by hand for control.

The next step was to try water drops on actual wildfires. In three trials during August the air tanker proved to be of considerable help to ground forces although in one of these it was apparent that too much was expected of a single plane.

The Mendenhall fire of August 12 covered about 400 acres in grass, brush, and timber; crowning uphill; weather hot, dry, and windy. The plane supported initial action forces on flank in grass and mixed oak with 240 gallons of water in 2 loads. Support was effective where used, but there was too much line for one plane to handle.

With the weather hot, dry, and windy, the August 13 Mendenhall fire of 700 acres was temporarily controlled at head and one flank. Lower end of fire, burning downhill in chamise, became too hot to handle by direct attack and threatened to outflank existing control lines. The plane, refilling repeatedly at nearby airport, delivered 600 gallons in 5 loads to 15 chains of lower end of fire. Fire cooled down enough so that attack forces were able to build control line along fire edge. Fire fighters stated they could not employ direct attack until flames were suppressed by plane. In this trial, 120 gallons applied in 6 passes was not nearly so effective as when applied in 3 passes.

The John David place fire on August 15 was in bottom of narrow box canyon with adjacent slopes rising 2,000 feet on one side and 5,000 feet on the other. Cover consisted of medium-density mixed brush with grass. Head of fire controlled but hot-burning corner threatened to outflank control line. Corner too hot for direct attack and moving too fast for indirect attack. Refilling at nearby airport, plane delivered 480 gallons in 4 loads to hot corner by flying up and down the canyon. Water cooled down hot corner enough to allow men to complete their control line close to fire edge. District ranger and others reported air tanker instrumental in control.

On initial attack the loaded plane was dispatched from its Willows base immediately after ground forces were started to fire. At the same time, aviation gasoline and a water tanker were sent to the airport nearest the fire. A reconnaissance plane, in communication with ground forces and the "refill" airport, correlated the ground and air activities. In the future the company plans to fly a maintenance mechanic to the airport to refuel and load the air tanker, do maintenance work as necessary, and prevent damage to the plane by well-intentioned but inexperienced personnel during the loading operations.

It was apparent that air delivery of water made this aircraft a practical fire fighting tool, but quantitative information was needed to improve tactical methods for water delivery. Accordingly, a limited series of tests was conducted to obtain the following information: (1) Effect of plane height, plane speed, and wind velocity and direction on amount and distribution of water received on the ground. (2) Amount of water loss to be expected during summer fire weather. (3) Effect on amount and distribution of dropping part of total load in each of several runs (multiple passes) with pilot aiming for same spot each time. (4) Practicability of dropping a sodium-calcium borate fire-retardant. (5) Amount of penetration of water and retardant into brush cover.

Although this aircraft can carry a maximum of 160 gallons of water, nominal full-load tests were made with 125 gallons of water or 100 gallons of retardant. At elevations normally experienced on the Mendocino National Forest this is the maximum safe load.

During the tests wind velocity varied from calm to 8 miles per hour, air temperature from 80° to 110° F., and relative humidity from 6 to 19 percent.

The patterns of distribution from these tests were roughly oval, from 4 to 7 times longer than wide. When the full load was released in one pass the greatest concentration of water was obtained when the airplane was flying at low speed and low elevation into the wind. Both higher speed and greater elevation increased the total length of pattern but gave lower concentration.

About 75 percent of the water reached the ground in measurable quantities in the low-altitude, low-speed, headwind tests: about 65 percent in the higher altitude, cross wind tests. At top speed and low elevation, about 70 percent of the water released reached the ground. Only 20 to 30 percent of the water reaching the ground was in concentrations of 1 gallon or more per 100 square feet. Apparently, wind direction and velocity are the most important factors affecting percent of water reaching the ground in a useful pattern.

Relatively high concentration was obtained when a 40-gallon load was dropped in one pass as compared with a 125-gallon load dropped in multiple passes. In making more than one pass with a capacity load, the manually operated outlet gate was only partially opened for each pass because it could not be closed against a full-stream discharge. As a result, only about half of the water reached the ground in measurable quantity. More rapid release of water should result in greater concentrations for all sizes of loads.

In medium and light brush there was no significant difference between the amounts of water received at the crown and on the ground. In heavy brush, however, there was considerable variation—from 20 to 90 percent as much water reaching the ground as was received at crown level.

Results from the retardant tests were similar to those obtained with plain water. However, the heavy sodium-calcium borate suspension, weighing 10 pounds per gallon, did not disperse as readily as water and had a smaller distribution pattern with particularly heavy concentration in the center. Penetration into heavy brush was more uniform than with water; 45 to 60 percent of the amount received at the crown level reached the ground. The standing brush was well coated with retardant.

Conclusions and Recommendations

These limited tests have shown that water or chemical dropped free-fall from small airplanes can have significant effect on small grass and brush fires, or on some parts of large ones. To obtain the greatest concentration of liquid on the ground, the airplane should fly as low and as slowly as conditions permit and as nearly into the wind as possible. The more rapidly water is released, the greater the concentration will be. Increasing the altitude or air speed or dropping in a crosswind will give greater area coverage but will reduce concentration.

As with all specialized tools, the aircraft used for aerial tankers must be in top mechanical condition. Also, pilots must be experienced both in flying under mountain conditions and in low-level air drops. Pilots are cautioned to watch for sudden jumps when releasing large amounts of water. They should avoid a tail-down plane attitude when dropping from low heights to minimize effects of slipstream on the water.

One aerial tanker has been of significant assistance to ground crews on fires. Indications are that several planes used in quick succession will not only be more efficient but may be able to hold temporarily short pieces of hot fire line. It is not necessary to evacuate the target area as these uncontained water drops are not dangerous to personnel.

Considerable work still needs to be done before the aerial tanker can become a common fire fighting tool. The optimum speed, altitude, direction of flight, and method of releasing the water or chemical for each tactical situation need to be determined. Information is needed on the amount of water or chemical required to affect fires under different fuel and burning conditions. More test drops should be made under a greater variety of weather and fuel conditions, particularly at wind velocities greater than those encountered in these tests. A means of closing the outlet gate against a full stream of water is needed to permit higher concentrations of water than are now possible in multiple-pass drops. Ground-to-air communication should be improved for better tactical use.

PACKBOARD HOSE LAY

Fire Control Personnel

Cajon Ranger District, San Bernardino National Forest

During the past two fire seasons, the Cajon District of the San Bernardino National Forest has developed a quick and efficient system for making a hose lay, by use of hose packed on a packboard. Where tankers cannot get close to a fire, a 600- to 800-foot hose lay can be run and water delivered at the nozzles in 2 minutes.

The pack consists of 100 feet of 1-inch cotton jacket or 200 feet of 1-inch nylon jacket hose, packed on a 10- by 21-inch packboard. The hose is tied to the packboard in such a manner that it will come off easily and not become tangled (fig. 1).

Using 100 feet of the cotton jacket hose, the packing is started with the male connection or nozzle first (fig. 1, *B*). The hose is then folded lengthwise on the packboard until there are 7 folds (hose overlaps the ends of the packboard about 3 to 4 inches). This layer is then tied tight in 3 places, using 2 strands of cotton string at each place. Ordinary light cotton string is used because it will break easily when the hose is run out.

After the first layer is securely tied, the second layer is placed on top of it with seven folds and the ends even with the bottom layer. This layer is then tied tight to the packboard with more string (fig. 1, *C*). The last layer has six folds, ending with the female connection on the side and near the bottom of the pack (fig. 1, *D*). This last layer is also tied to the packboard with string. To insure against the pack coming apart before it is ready to use, the whole pack is tied with two straps that are fastened to the packboard (fig. 1, *A*).

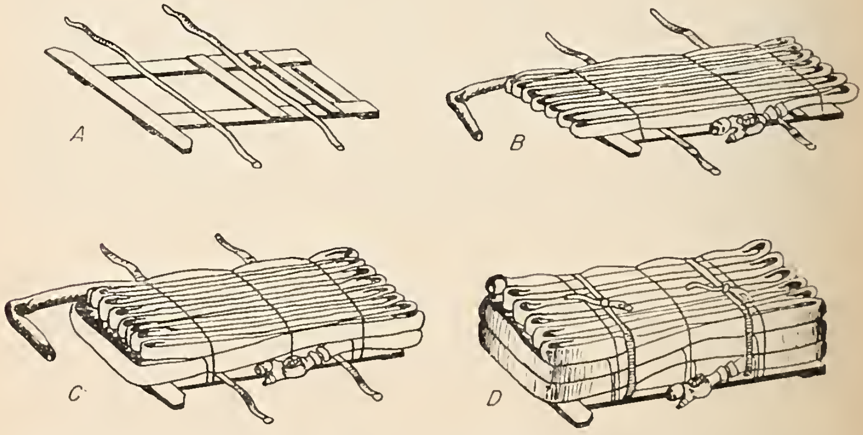

Figure 1.—*A*, Packboard ready, with straps, for loading hose; *B*, *C*, *D*, layers of hose properly placed and tied.

If 200 feet of nylon jacket hose is used, the procedure is the same, except the first layer of hose has 14 folds. The second layer has 13 folds, and the third layer 12.

One siamese hose lay, of which many variations can be used to meet varying conditions, requires a 5-man crew with at least 1,000 feet of hose. Initial hose lay consists of 200 feet of 1½-inch cotton jacket, rubber-lined hose, 800 feet of 1-inch nylon jacket, rubber-lined hose in 4 packs, a 1½- to 1-inch reducer siamese shut-off valve, a 1-inch siamese shut-off valve, and 2 nozzles.

Foreman carries packboard with 200 feet of 1-inch hose and nozzle, and pulls 1½-inch hose with reducer siamese out 200 feet from tanker. To the siamese he attaches the hose packed by No. 1 nozzleman who is following 20 feet behind him. Foreman, No. 2 nozzleman, and utilityman proceed 400 feet out to position for 1-inch siamese. Utilityman hooks foreman's hose to one side of siamese and No. 2 nozzleman's hose to other side. Foreman starts flanking fire in one direction, No. 2 nozzleman in the opposite direction. When No. 1 nozzleman arrives with more hose, the foreman gives him nozzle and is then free to direct action on fire.

No. 1 nozzleman, who has been 20 feet behind foreman helping pull 1½-inch hose, proceeds 200 feet after his hose is hooked up to siamese. He then hooks the utilityman's hose to the hose lay, and returns to siamese to await signal from utilityman to turn on water. After turning on water, he takes pack with 200 feet of hose, which has been brought to the first siamese by the truck operator, and proceeds out hose line to relieve foreman of nozzle. The hose he is carrying is extra.

Utilityman takes packboard with 200 feet of hose and the 1-inch siamese. He follows 20 to 30 feet behind No. 1 nozzleman and helps pull 1½-inch hose. He stays behind No. 1 nozzleman until 200 feet beyond first siamese. Here his hose is hooked into hose lay, and he follows foreman 200 feet to where he attaches second siamese. He then signals No. 1 nozzleman for water to this point. After this, he hooks foreman's hose to one side of siamese and No. 2 nozzleman's to the other. He then controls the water from this point or can go after tools and more hose.

No. 2 nozzleman, carrying packboard with 200 feet of hose and nozzle, follows 20 to 30 feet behind utilityman and helps pull 1½-inch hose. When he reaches second siamese his hose is hooked up to one side and he proceeds 200 feet around fire.

Tank truck operator checks truck and starts pump to charge 1½-inch line to first siamese. He takes shovel and packboard with 200 feet of hose to the siamese and then stands by where he can control the pump or the siamese in case of broken hose. He also acts as utilityman in relaying hose or tools.

FIRE EXTINGUISHERS, THEIR TYPES AND USE
V. VAPORIZING LIQUID

A. B. Everts

Equipment Engineer, Division of Fire Control, Region 6, U. S. Forest Service

Vaporizing liquid is perhaps the best known, after water, of the extinguishing agents. This type of extinguisher[1] is often referred to as a "Pyrene," which is the name of only one of the many companies that manufacture this particular type of pump-gun. The layman thinks of vaporizing liquid as carbon tetrachloride (referred to as CTC), but this is not the only one or even the best. And therein lies the renewed interest in vaporizing liquid. Many compounds, with long names, are still undergoing tests and the best one probably has not yet found its way into general use.

Vaporizing liquid, as the name indicates, is a liquid that when directed on a fire quickly vaporizes into gas. The gas smothers the fire. An intense fire will bring about quicker vaporization than a smoldering fire. Since a smothering agent will not cool the burning fuel, vaporizing liquid is not as effective on Class A[1] fires as a quenching and cooling agent; that is, water or foam. However, vaporizing liquid (VL) will, and has, extinguished many small fires of this type. Success depends on the type of fire. Paper burning in a metal wastebasket, for instance, can be quickly snuffed out by VL (as by CO_2), but fires in overstuffed furniture, wood, or other deep-seated fires are not that easily handled. Reignition will quickly follow. VL is rated as a Class B and Class C extinguisher, but because of its knockdown of small Class A fires, it is often thought of as a universal type of extinguisher.

In a series of test fires, 8 pounds of pine needles making a layer about 2 inches thick in a 4- by 4-foot frame were used. The fire was extinguished only once by ½ quart of CTC; in other attempts, reignition occurred immediately. This is why timber fallers using power saws on national-forest timber sales in some regions are required to carry a shovel. The small extinguisher may handle a small gasoline fire, but when the fire involves forest fuels, a shovel is needed to build line or throw dirt.

How to use the extinguisher.—On Class A fires, direct the VL stream at the base of the flames. On Class B fires (flammable liquids) best results are obtained when the discharge from the extinguisher is played against the inside of the wall of the container, just above the burning surface. The stream should not be directed into the burning liquid. Where possible, the operator should walk around the fire while directing the stream so as to get maximum coverage during the discharge period.

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[1] For more information on classes of fires and types of extinguishers see: *Fire Extinguishers, Their Types and Use. I. Carbon Dioxide Extinguishers, II. The Dry Chemical Extinguishers, III. Water-type Extinguishers,* and *IV. Foam Extinguishers,* by A. B. Everts. Fire Control Notes 15 (4): 1-5, illus. 1954; 16 (1): 9-12, illus. 1955; 16 (2): 24-26, illus. 1955; 17 (1): 12-13, illus. 1956.

On Class C fires, especially fires in live electric motors, VL is an excellent extinguishing agent. The reason is that the stream can be directed into the small openings of the motor housing easier than is possible with CO_2 or dry chemical. There is no danger from electric shock and no residue is left on the motor.

Types of VL extinguishers.—There are a number of types and sizes of VL extinguishers:

1. The hand pump type, which has ben in use for many years, is manufactured in a number of sizes: 1-, 1¼-, 1½-, and 2-quart, and 1-, 2-, and 3-gallon.

2. Stored pressure type (figs. 1 and 2). All the major manufacturers now make VL extinguishers that can be pressurized with air, CO_2, or nitrogen. This type has a gage by which the pressure can be easily checked to insure that the extinguisher is properly charged. Internal pressure is usually 150 pounds. Most of these are 1-quart size.

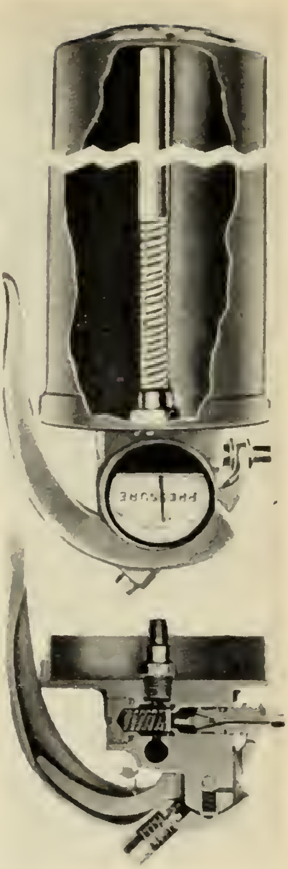


FIGURE 1.—Cutaway of a stored pressure VL extinguisher. The inside siphon tube is flexible so that more of the liquid can be discharged when the extinguisher is in a near horizontal position.

These extinguishers can be charged directly from a service station air chuck, the same as is used to inflate tires. All service stations, however, do not carry 150 pounds' pressure on their compressors. CO_2 is favored as a pressure medium. However, if CO_2 is used in cold climates, the pressure decreases as cold weather sets in. The pressure can be brought up to the recommended 150 pounds, but as spring and summer come around again, some of the pressure should be drained off. This can be done by turning the extinguisher upside down and releasing some of the CO_2 gas.

3. "One-shot" disposable extinguishers. These contain 16 ounces of CTC and are pressurized with CO_2. A small copper tube runs to the bottom of the can. To put the extinguisher into use, a ring is pulled to break the copper tube where it is crimped at the top of the can. These extinguishers are comparatively cheap.

4. The little 8-ounce pressurized extinguisher that is carried by many timber fallers for use on power saw fires. The agent in this extinguisher is chlorobromomethane (CBM).

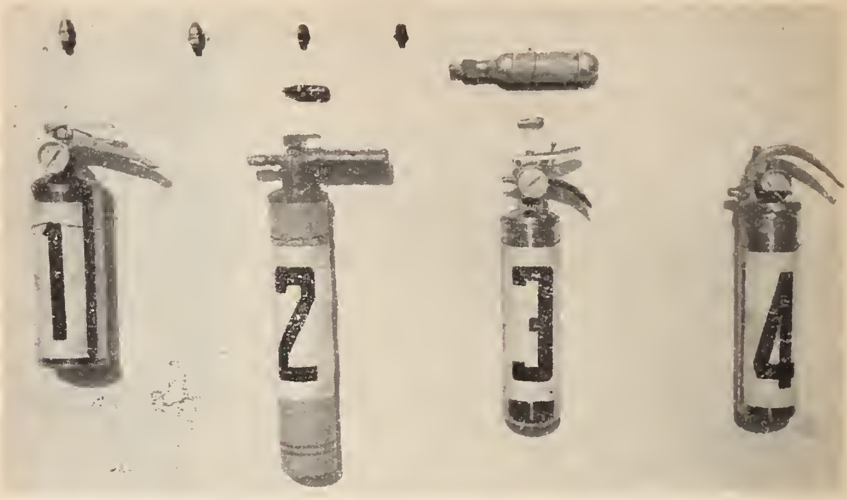


FIGURE 2.—Extinguishers 1, 3, and 4 are all 1-quart VL stored pressure extinguishers. All have pressure gages. Extinguisher 3 can be pressurized in the field with the large CO_2 cartridge shown above it. Extinguisher 2 is a 1⅜-quart water type of extinguisher known as "aircraft type," and designed for Class A fires in cabins of airplanes. It is pressurized with a small CO^2 cartridge which is inserted in the handle and ruptured (by turning) when put into use. The four small objects, upper left, are small capacity fog nozzles used on these extinguishers in an experiment to see whether fog is more effective than a straight stream.

While all these extinguishers were designed for using vaporizing liquids, there is no reason why they cannot be used for expelling any kind of liquid. A fog tip will give spread, if such is desired. The aircraft type, using plain water, is good protection for Class A hazards in the home. A fire retardant can also be used. There is a wide price range depending on the type and size.

Types of vaporizing liquid.—There are a number of vaporizing liquids used in fire extinguishers:

1. Carbon tetrachloride is the best known and the cheapest. It is treated with components for depressing the freezing point to 50° F. below zero.
2. Chlorobromomethane (CBM), aslo called bromochloromethane, is a German discovery. It is claimed that 1 pound of CBM is equal to 2 pounds of CTC. It will not freeze at temperatures above 100° F. below zero. CBM is more expensive than CTC.
3. Azeotropic chloromethane (CM-7) is still another compound recently developed which, it is claimed, will not produce toxic gas as the result of application to a fire.
4. Bromotrifluoromethane has shown remarkable extinguishing ability in tests conducted by the Navy.

There are others. Some of them are used in mixtures with methal bromide and with ethyl bromide. Research objective is to find a low freezing point liquid, with the greatest fire extinguishing ability, without a hazardous release of toxic gas.

WARNING: Too much stress cannot be placed on extreme care in the use of VL fire extinguishers in enclosed places. This is especially true of CTC. It should never be used as a cleaning solvent. Take heed to Robert Palmer, Industrial Hygiene Engineer, Oregon State Accident Commission, who reported: "No intelligent person would think of running his automobile in a garage with the doors closed, yet carbon tetrachloride is *four times as poisonous as carbon monoxide.* It is nearly half as dangerous as deadly hydrogen cyanide. Phosgene gas, produced when carbon tetrachloride comes in contact with any hot surface, is *ten times as toxic as hydrogen cyanide.* Three-fourths of a teaspoonful of carbon tetrachloride, evaporated and equally distributed in the air of a room 10 feet long, 10 feet wide and 10 feet high, will produce a toxic concentration. Just three drops of carbon tetrachloride, sprayed onto a fire and converted into phosgene will affect the health of a person in the same room . . . .

"There are many more cases of minor to severe carbon tetrachloride poisoning on record, and no one knows how many unreported cases because the symptoms of carbon tetrachloride poisoning are often just like kidney or liver ailments of an organic nature. Also the effects are often slight and temporary. That is, they seem to be temporary, but the damage done by carbon tetrachloride is permanent and the effects may not show up for months or even years after exposure and the unfortunate victim may have forgotten that he was ever exposed at all."

If you are depending on CTC for home protection for an oil furnance or stove, or for an electric range, be sure you, your wife, all members of your family are aware of this hazard. It is probably safer to change to CO_2 or dry chemical.

Maintenance.—The principal point in connection with maintenance of CTC extinguishers is to use a good grade of liquid, not the type that is used for cleaning. In inspections, pour the liquid into a clean container. If a gray scum is detected it is probable that the liquid is of inferior quality and that water is present. Even a minute amount of water will form hydrochloric acid which will cause corrosion.

Always make sure that the discharge port or nozzle is open and that the pump operates correctly. In the pressurized type, check the gage to be sure the pressure is right.

The manufacturers say "never use water in the extinguisher." What they really mean is that water should not be used to test the extinguisher because of the danger, as stated above, of forming hydrochloric acid when the extinguisher is filled with CTC again. There is no reason why these extinguishers cannot be used as "water type" extinguishers, especially with retardants and a noncorrosive wetting agent.

Summary.—(a) The VL type extinguisher is for flammable liquid fires and for fire in electrical apparatus. It is also effective on some types of small fires in paper, textiles, wood, or similar debris. (b) It is by far the most dangerous (if vapors are breathed) of all the five common types of extinguishers. Anyone who might use the extinguisher should be warned of the hazard. CTC in contact with flame forms gases that are dangerously toxic. All other chemicals are reported to be toxic to some degree. (c) Range of projection varies according to pressure medium, type of extinguisher, and whether the liquid is discharged in a spray or straight stream (20-30 feet in some straight stream types). (d) Costs cover a wide range, depending on type and size. (e) Maintenance requires an annual check and use of a good grade liquid.

Grenades and spray devices.—In addition to the extinguishers already described, there are a number of grenades meant to be thrown at a fire. There are also wall and ceiling spray devices, some of them pressurized with CO_2, with fusible links which will bring about automatic release when the temperature reaches 160° F. Many of these are excellent when properly installed, but it is obvious that a toxic agent should not be used in such devices in any location where there is the possiblilty of the released fumes or gases being breathed by humans.

☆ ☆ ☆

Portable Fuel Moisture Scale

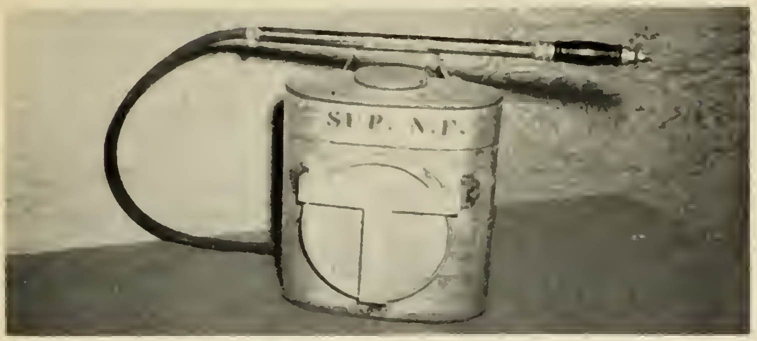
Increased research in fuel moisture problems and increased interest in using paired sticks in the timber edge and in the slash as a guide to slash burning raised a demand for a portable fuel moisture scale that could be carried from station to station. Since none was available, the standard scale was adapted in the following manner.

A level vial was secured to the face of the scale near the graduation arc. The scale was then put into a vise and the standard 100-gram weight attached to the balance in the usual manner. With the slide set at 100, the scale was then rotated to obtain a reading of "0." In this position the level bubble was set to read level. To operate, the scale is held at the top edge by the right hand and rested vertically on any support. The fuel moisture sticks are hung on the scale, the level bubble is brought to center and held there while the fuel moisture is read from the graduation arc in the usual manner.

Because some situations do not provide a place to rest the scale, a staff with brackets was provided. This staff is a standard ½-inch by 4-foot dowel rod with a short pin in one end. Two small angle aluminum brackets were attached to the center back of the scale plate. The bottom one had a ½-inch hole drilled and reamed to allow the dowel to slide freely. The top bracket had a smaller hole for insertion of the pin in the dowel. To operate, the dowel is slid through the bottom bracket and the pin inserted in the top bracket. The staff is rested on the ground, the scale grasped in the right hand and the fuel moisture read as previously explained.

In some locations, wind swinging the sticks is a problem. This can be solved by a sheet of metal bent in a "U" and staked in a vertical position at the site. The scale is then rested in a position so that the sticks hang inside this wind deflector. A similar wind shelter may be made by driving three 1- by 6-inch picket boards into the ground.—William H. Larson, *Chief Fire Warden, Washington Forest Fire Association.*

Bracket on Backpack Can for Canvas Bucket



A T-shaped bracket, cut from medium-gage galvanized tin, is soldered to a backpack pump can. This is a handy way to keep a collapsible canvas bucket readily available for filling the pump.—LOUIS F. DEYAK, *Fire Control Aid, Superior National Forest.*

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Fire Prevention Note

During the 1955 hunting season, the Coconino National Forest, Southwestern Region, used a short form letter as a means of contacting hunters and campers who were not in camp at the time the fire prevention guard or patrolman passed by. The mimeographed letter was printed on golden-orange paper to obtain greater legibility and as a reminder of the Forest Service Golden Anniversary. It read as follows:

> Dear Mr. Hunter:
>
> One of your Forest Rangers has visited your camp while you were out. The reason you probably picked this spot to camp is that it is located in a place you thought to be clean and beautiful. When you are ready to leave, please look at it once more and ask yourself if it looks the same as you found it. Others will appreciate anything you do to help keep your camp and the woods clean.
>
> As you know, the forest is extremely dry and FOREST FIRES may start at any time. Please build your campfire on bare ground, in a safe place, away from logs, brush and litter. Make sure your fire is DEAD OUT whenever you leave camp. The Ranger who visited your camp may have some suggestions to make that may help you.
>
> 1.
>
> 2.
>
> Thank you for your cooperation. Please stop one of our fire patrolmen if they can be of assistance.
>
> Good luck on your hunt.
>
> Very truly yours,
>
> Forest Supervisor
>
> By

There was also sufficient space on the form for the patrolman to offer suggestions that would help the sportsman to enjoy his stay in the Forest.

(This is a good reminder of a practice used from time to time in various other Forest Service regions. For example, the "courtesy ticket" includes smoking rules in effect at the time. Thus, the visitor is informed on the specifics of safely using his Forest playground.—Ed.)—Franklin O. Carroll, *Assistant Fire Staffman, Coconino National Forest.*

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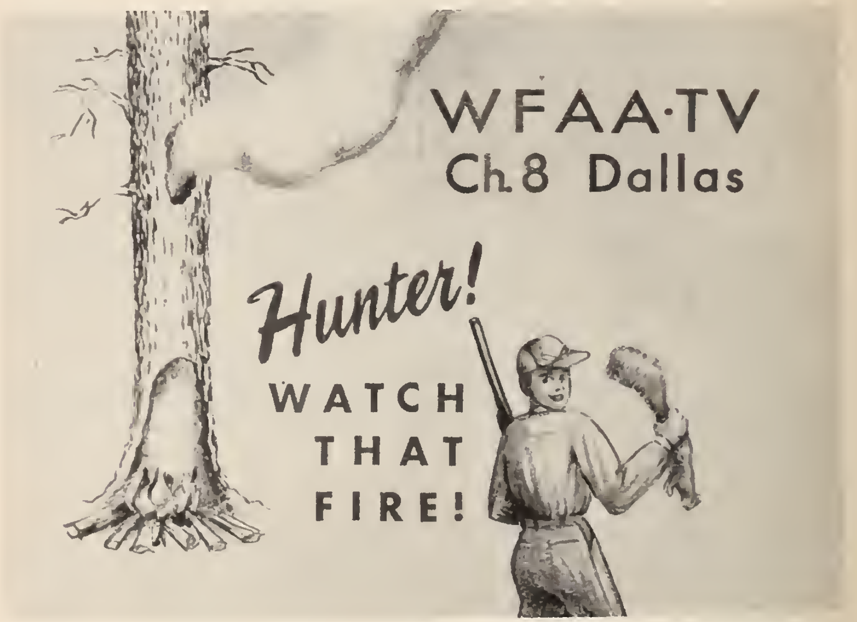
TV Helps Prevent Forest Fires in Texas

Texas leads the Nation with 35 television stations operating in the State. Construction permits have been issued for an additional 10 stations. There are more than 90,300 television sets on Texas farms and ranches—nearly 1 for every 3 rural homes.

Approximately 25 percent of all woods fires in Texas in 1954 were caused by hunters. To discourage them from smoking game out of hollow trees and otherwise causing forest fires, much of the fire prevention effort in the State is directed toward hunters.

Chester O'Donnell, audio-visual aids specialist, Texas Forest Service, has prepared a series of station-break slides. The fire prevention message, station call letters, and channel number appear on each slide. Brief fire prevention copy is provided for the announcer to read while the slide is in view.



Several other station-break slides on related subjects have been prepared and distributed to Texas TV stations. These include "Observe Arbor Day" and "Use Your Ash Tray." In addition, Texas television stations are making extensive use of educational forestry motion picture films and some live forestry programs.

Through the use of television the Texas Forest Service is bringing forest fire prevention messages to the homes of many people who were never reached before.—E. R. Wagoner, *Associate Forestry Educator, Texas Forest Service.*

INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page.

The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

Any introductory or explanatory information should not be included in the body of the article, but should be stated in the letter of transmittal.

Illustrations, whether drawings or photographs, should have clear detail and tell a story. Only glossy prints are acceptable. Legends for illustrations should be typed in the manuscript immediately following the paragraph in which the illustration is first mentioned, the legend being separated from the text by lines both above and below. Illustrations should be labeled "figures" and numbered consecutively. All diagrams should be drawn with the type page proportions in mind, and lettered so as to permit reduction. In mailing, illustrations should be placed between cardboards held together with rubber bands. *Paper clips should never be used.*

When Forest Service photographs are submitted, the negative number should be indicated with the legend to aid in later identification of the illustrations. When pictures do not carry Forest Service numbers, the source of the picture should be given, so that the negative may be located if it is desired.

India ink line drawings will reproduce properly, but no prints (black-line prints or blueprints) will give clear reproduction. Please therefore submit well-drawn tracings instead of prints.

SMOKEY
PLEASE BE CAREFUL...
with matches
with smokes
with campfires
with every fire!
SMOKEY
Remember-Only you can
PREVENT
FOREST FIRES

VOL. 17 JANUARY 1956 No. 1

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FIRE CONTROL NOTES

A PERIODICAL DEVOTED
TO THE TECHNIQUE OF
FOREST FIRE CONTROL

FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE

FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and techniques may be communicated to and from every worker in the field of forest fire control.

JAMES C. SPACE

Volume 17 Number 1

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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PAPER BAGS FOR AERIAL WATER BOMBING OF FOREST FIRES

A. P. LESLIE AND J. D. NICHOLS
Division of Research, Ontario Department of Lands and Forests

The Ontario Department of Lands and Forests became sufficiently interested in the possibility of forest fire suppression by bags of water dropped from aircraft to conduct field tests in the Sault Ste. Marie district in 1949. This form of attack showed definite merit and was developed into an efficient aid in fire suppression operations.

Water bombing of forest fires is selective and the effectiveness is limited, but it is felt that this practice can play an important part in the suppression of forest fires and will continue to do so until such time as helicopters are readily available.

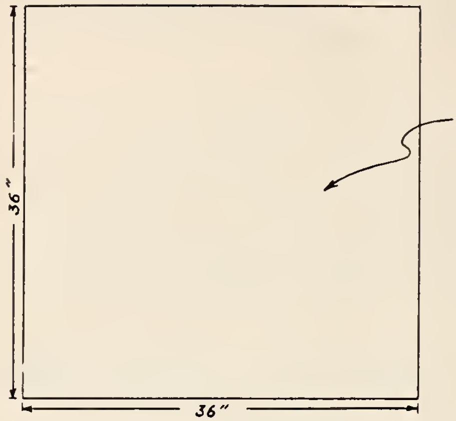
This attack is primarily intended to retard the rate of spread of small forest fires in situations that are difficult to reach on the ground. Under such conditions it may slow down the fire until suppression crews reach the area. The method has been found effective also in assisting fire fighting crews in bringing portions of the fire edge of large fires under control and has proved quite good on these fires during the early hours of the morning. Assistance to the suppression crew is carried out through the medium of air-to-ground and ground-to-air communication and care is taken that no bombs are dropped until the suppression crew has retired from the target area.

The water bombing of small, inaccessible fires generally follows a set pattern. The aircraft lands on the nearest water, two smokechasers are dispatched to the fire, a third man is kept to assist the pilot in the water bombing operation. The water bombing equipment is installed, 17 to 24 bombs are filled with water, and the bombing begun. Bombs are dropped in salvos of up to eight per salvo.

The water bombing equipment used in the standard De Havilland Beaver aircraft of the Department consists of conveyer, camera hole fixture, water bombs, and pail for filling water bombs. Description of this equipment and procedure followed during bombing operations is available in a technical bulletin, Aerial Water Bombing Instructions, issued by the Ontario Department of Lands and Forests.

The water container bag or "water bomb" is manufactured to Department of Lands and Forests specifications, as illustrated in the accompanying diagrams, by a specialty firm who assisted and worked with the Department on the development of this bag. Fifty- and sixty-pound wet strength Kraft papers, plasticized and coated with a self-seal adhesive compound are used in the manufacture of the water container bag. The properties of the adhesive compound make the bag waterproof and supply a quick and efficient method of sealing.

Diagram 1



PAPER STOCK USED FOR INNER BAG. ONE SIDE TREATED WITH LATEX.

Diagram II

FOLD ON BROKEN LINES TO FORM CORNERS SHOWN ON NEXT DIAGRAM; FOR INNER BAG PLACE ON FOLDING STAND, TREATED SIDE UP.

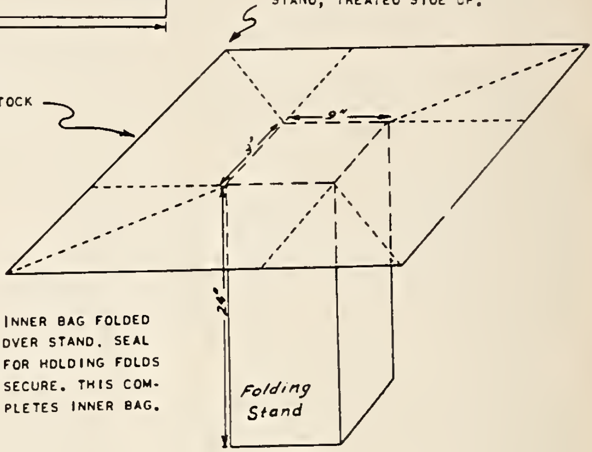
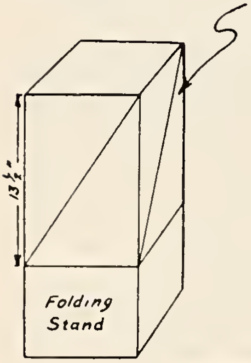


Diagram III

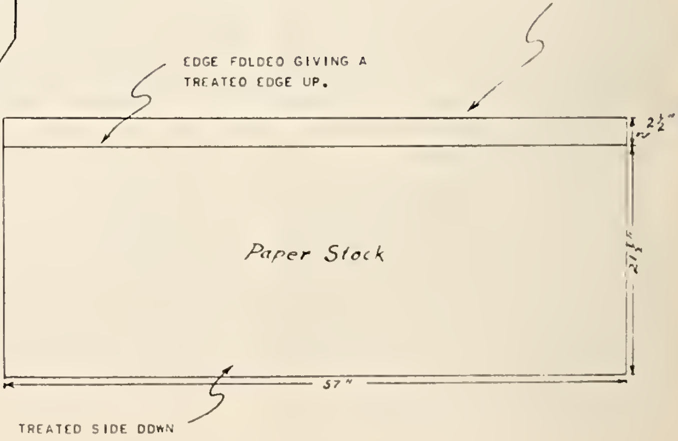


INNER BAG FOLDED OVER STAND. SEAL FOR HOLDING FOLDS SECURE. THIS COMPLETES INNER BAG.

Diagram IV

DIAGRAM #1 FOR SECOND PLY

EDGE FOLDED GIVING A TREATED EDGE UP.



TREATED SIDE DOWN

Diagram V

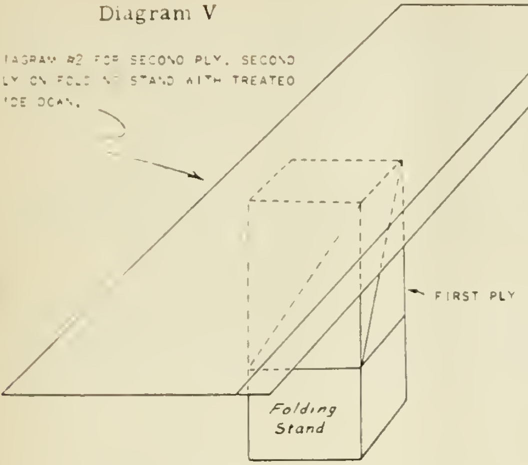


DIAGRAM #2 FOR SECOND PLY. SECOND PLY ON FOLDING STAND WITH TREATED SIDE DOWN.
FIRST PLY
Folding Stand

Diagram VI

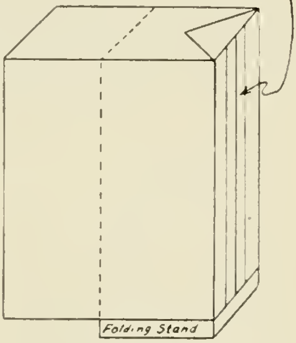

LATEX EDGE REVEALED TO HOLD SEALING STRIP. ALSO TO FORM SEAL WHEN BAG IS FILLED.
Folding Stand

Diagram VII

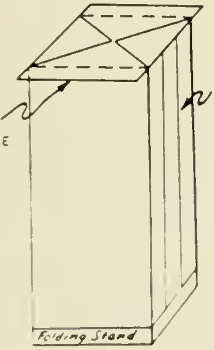


Diagram IX

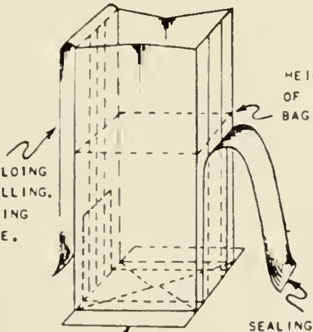

HEIGHT OF INNER BAG
WAX PAPER INSERTED BEFORE FOLDING TO KEEP ONE SIDE OPEN FOR FILLING. ALSO TO KEEP BAGS FROM STICKING TOGETHER WHEN STACKED IN PILE.
SEALING FLAP, LATEX SIDE
CARDBOARD BASE

Diagram VIII

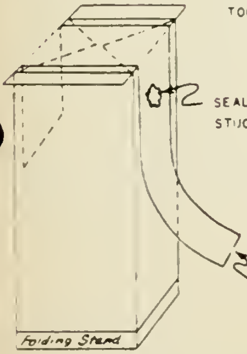
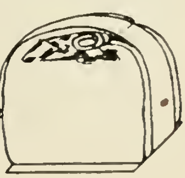


Diagram X


SEALING FLAP IS PULLED OVER AND SECURED AFTER BAG HAS BEEN FILLED.

On the top 7 inches of the bag, the sealing compound is on the inside of the paper and forms the watertight seal when closed. This seal is prevented from sticking before use by the insertion of a piece of waxed paper that is removed and thrown away when the bag is filled. The compound is between the two layers of paper on the rest of the bag which is the container section.

To give rigidity when filled, a piece of treated cardboard is held to the base of the bag by the sealing flap as shown on the accompanying diagrams. Correct folding of the outer ply of paper forms a sealing strip on the side opposite the flap side.

When the bag is filled with water the top section is sealed and folded down onto the top of the container section and held in this position by attaching the sealing flap to the sealing strip. Filled and sealed correctly the bag roughly resembles a cube. Specification details are as follows:

Paper		Kraft, wet strength.
Inner ply		60-pound.
Outer ply		50-pound.
Self-seal compound		Latex.
Dimension of base of bag	inches	9 x 9
Dimension of cardboard	do	9 x 11
Height of bag	do	18
Width of mouth opening	do	9
Width of sealing flap	do	7
Width of sealing strip	do	4
Dimension of bag when filled	do	11 x 11 x 11
Capacity of bag	gallons	3.5

* * *

Fire Finder Maps: Protected, Yet Kept Up-to-Date

Most methods of protecting the maps on top of fire finders require coating with transparent liquids or impregnation as in the Lamacoid process. The disadvantage is that once the map is treated no changes can be made either in the road locations or in the ownership status. To overcome this disadvantage we have used the following method. It is cheap, easy to use, not messy. Changes can be made on the base map as often as needed.

The untreated base map, after it has been mounted on the map plate, is covered with a sheet of heavy glass called "crystal sheet" in the glass trade. This is almost as heavy as plate glass, but much cheaper; a 20-inch circular piece costs $4.65 at today's prices. The untreated map is mounted on the circular, removable base of the Osborne fire finder with rubber cement. We remove the center pin used to center the map in order to eliminate the need for having a hole bored in the glass. The map is oriented in the usual manner, and the screws tightened down. Then the piece of crystal sheet glass is placed over the map. This protects the map yet may be readily removed so that changes can be made.—A. J. Quinkert, *District Ranger, Wayne-Hoosier National Forest.*

PROSPECTS OF EXTINGUISHING FIRES FROM THE AIR

A. A. Brown

Chief, Division of Forest Fire Research, U. S. Forest Service

Aircraft have participated in varying degrees in forest fire fighting since 1919. At first, use was limited to detection or verification of the existence and location of small fires and to aerial reconnaissance of large going fires.

We did some experimenting in the late thirties on the possible effectiveness of spraying or bombing fires with water and other extinguishers. We found at that time that free liquids released from a plane dissipated so rapidly in the air that very low flying would be required. Mountainous terrain, turbulent air, and poor visibility due to smoke ruled this method out at the time. Preliminary tests of water bombing showed some promise, but the low capacity of planes available and the lack of suitable facilities discouraged operational use.

However, experimental and other test work at this time demonstrated the feasibility of delivering men and equipment close to a fire in roadless country by parachute. Intensive work was done in developing suitable parachute equipment and methods that could reduce safety hazards of such an operation and that could make it a feasible substitute for numerous but widely disseminated, seasoned ground fire fighting forces. This was accomplished in 1940 to a degree that "smokejumpers" and aircraft became a regular part of the forest fire fighting organization for the large blocks of roadless forest country that exist in parts of Idaho, Montana, Washington, Oregon, northern California, and New Mexico. The complete story of smokejumping is separately available.

Further development of aerial methods of detecting fires has also taken place and the substitution or supplementing of fixed lookout systems by regular patrol from the air has proved its value, particularly where lighting fires are prevalent and forest fuels are relatively slow burning.

These uses of airplanes are successful and are now well established. In addition, small helicopters have come in for increasing use for shuttle service on large fires. Their ability to move key men or critically needed equipment up a mountain slope or across rugged terrain in minutes compared to hours, and their ability to land in a small, hastily prepared spot are such valuable assets, that high cost of such service, limited carrying capacity, and their inability to carry sizeable loads when operating from landing spots at high elevations, have not prevented fire agencies from taking advantage of their capabilities. But these uses are primarily a matter of aerial transportation. The attractive possibilities of utilizing helicopters and fixed-wing airplanes to fight fires directly have not developed very far to date.

In 1947 a renewed effort was made to develop aerial bombing of forest fires as a joint project with the Air Force. The purpose was to test the effectiveness of such methods and to develop equipment and technics adaptable to military planes and operations. Good results were obtained on small fires with large water bombs exploded at treetop heights dropped from B-29's and modified wing tip tanks dropped from P-47's by skip or dive bombing technics. In typical forest fuels, fires of ¼ acre or less were never fully extinguished but the spread was stopped and burning was held down to a point where there was ample time for a small ground crew to get to the fire in an inaccessible location to complete the job. The effect on large fires was less encouraging with the methods used.

In 1948 the propeller drive fighter bomber aircraft used successfully in bombing small fires became obsolete for military purposes. At that time new jet type fighters were not believed suitable for such missions in mountainous areas. Because of priority of military requirements it was not considered practical for the Air Force to commit a fleet of bombers with crews in the degree of readiness necessary for further tests on an operational basis. For such reasons, the Air Force withdrew from the experiments leaving many questions unanswered.

Since that time many economic and technological changes have occurred that justify a new look at all possibilities. Timber and watershed values and cost of fire protection by ground methods have increased enormously. The cost of aerial operations has not increased in the same proportion. Similarly, plain water delivered through a nozzle onto a going fire is no longer "cheap." So new "expensive" additives that can increase its extinguishing power might pay off handsomely. The capabilities of aircraft have been enhanced and the tactical and strategic measures that they might carry out successfully need not be confined to bombing.

If dropped in sufficient mass, water can be delivered in an effective pattern from much higher flight levels than we have previously believed possible. Plastic or paper envelopes might serve in other situations and large carrying capacities might offset to a considerable degree what has formerly been regarded as a prohibitive cost of transporting water in the volumes necessary to have a definite effect on a fast-burning fire front. Usually, it would be necessary to apply ¼ to ½ inch of water per unit area to most of the burning area to have much effect.

If a standard of this order is assumed, the prospects of directly extinguishing a large fire that has assumed conflagration proportions appear quite remote. An airplane with a 2,500-gallon load of water or liquid extinguisher might accomplish it for an area of only a half acre or less. Larger capacities such as possessed by the C-74 or C-124 would increase the possible area of coverage. But it is apparent that a prohibitively large fleet would be necessary to have a positive extinguishing effect on a large fast-moving fire of several thousand acres. Such a fire sets up violent convection currents which also create dangerous hazards to aircraft. For these reasons even large capacity for carrying extinguishers does not offer a ready solution to such situations.

In spite of such limitations, there are critical situations in the early spread of every fire when extinguishing action at the right time and place on only a portion of its perimeter would insure prompt control of the fire at great savings in damage and fire fighting costs. Too often such action is beyond the resources of ground fire fighting forces in rugged terrain.

It is for these reasons that even limited but timely action from the air offers attractive possibilities. To realize such possibilities in emergency operations, we believe a systematic research and development program, including a series of extinguishment tests, will be necessary. So far personnel and facilities available for such purposes have been too limited to enable a satisfactory rate of progress.

In 1953 disastrous fires in southern California focused attention again on the need to develop new and better methods of reducing the disastrous losses inflicted by runaway fires. All fire agencies in that area volunteered help in organizing a project to test out a number of unconventional methods and ideas. Since defense against such fires is also a grave problem in civil defense, the Federal Civil Defense Administration gave sponsorship and six branches of the Department of Defense gave assistance in various ways. With this remarkable pooling of resources and interest, an ambitious and highly successful one-year exploratory project, known as Operation Firestop, combining field and laboratory tests was carried out.

They demonstrated that new chemical retardants have possibilities of effective application from the air, that water in sufficient volume, can be released suddenly from a modified torpedo bomber and delivered on a fire with considerable accuracy without undue loss in the air, that small helicopters have many tactical possibilities for laying hose, and for first-aid action in fire fighting that have not been exploited, and that large helicopters can deliver men and fire pumps with water to any part of a fire in rugged topography at will and can apply water to a fire at close range.

This has been a fine start. Of necessity Firestop had to be largely exploratory. Few of the new things tried could be developed to a point where they could be applied directly by fire agencies. Much further research and development is needed. It will be costly. It calls for a much stronger research staff than has so far been available to the Forest Service. But there is so much loss and human suffering at stake and the problem is so important to wartime defense that many are optimistic that ways will be found to solve the many problems that still exist in making fire fighting from the air a new stage in the progress of forest fire control.

The prospects of extinguishing a fully developed conflagration from the air are still not encouraging. But there are excellent prospects of preventing such a conflagration from developing by early aerial action. The prime advantage of aircraft is in their capability for speed and for access, which can increase success in taking action at the right time and right place. Inability to do so at critical times is the major handicap of ground forces under conditions of heavy cover and rugged terrain. Much may be accomplished by "first aid" from the air at the moment a fire is on the point of escaping from ground forces.

The many small but timely actions that might be taken directly from the air to help the fire fighter on the ground to win more victories can be summed up in military terms as *giving close aerial support* to *ground fire fighting.* Most forest fire fighting agencies agree that a full program of research to develop aids in this way and to develop new methods is very much needed.

☆ ☆ ☆

Published Material of Interest to Fire Control Men

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METEOROLOGICAL PROBLEMS ASSOCIATED WITH MASS FIRES

DEVER COLSON
U. S. Weather Bureau

Weather plays an important role in the behavior of mass fires. The knowledge and understanding of the meteorological conditions existing prior to and during these fires are essential for efficient fire fighting and control in both urban and rural situations. Ordinary fires or even large fires which are burning and spreading in a regular manner do not present the major control problems. Serious situations often develop when what seems to be a routine fire suddenly intensifies or begins to spread at a greatly increased rate or changes its direction of spread abruptly. In forestry parlance, the term "blow-up" or "explosive" has been applied to such forest fires since these fires often seem to explode. However, many fires have been designated as "blow-ups" simply because of a lack of understanding of the factors controlling the behavior of these fires.

There is much to be learned both in identifying these factors and in forecasting the occurrence of these factors. Some of the possible meteorological factors will be discussed briefly in this paper.

General burning conditions.—Most serious fires occur with extremely low fuel moisture caused by severe or extended drought conditions. These conditions are usually combined with high surface temperatures and low relative humidities and often with strong surface winds.

One notable example involved the famous Chicago fire on October 8, 1871, and the associated fires in Wisconsin and Michigan on the same day which burned over 1,000,000 acres, including the entire town of Peshtigo where over 600 lives were lost. Weather data indicate extreme dryness and strong winds on that date. On days with less hazardous burning conditions, these fires might well have been controlled before they had reached such disastrous proportions.

In the preparation and planning for the fire bombing raids over the Tokyo area, weather conditions were studied in connection with brush fires in North Carolina, a region climatically similar to the Tokyo area. The following factors were used: precipitation, relative humidity, and maximum wind speed. The maximum wind speed on the day of the fire was used while the precipitation and relative humidity were weighted over the day of the fire and the three previous days. These same factors are used directly or indirectly in most current fire danger rating systems.

Surface wind patterns.—The details of the surface wind patterns are necessary for efficient fire fighting operations. These details would include: the actual local surface wind patterns; the diurnal variations in these patterns; and the dependence of these local patterns and their diurnal variations on the surface pressure patterns as well as frontal and storm passages, the upper level weather patterns, atmospheric stability, wind and temperature profiles, and topography.

A knowledge of the local wind patterns and their variations is even more essential in areas of rugged terrain. In these areas, there are the additional effects of general drainage patterns (mountain and valley winds) and the diurnal up- and downslope winds due to the differential heating of the slopes. The relative influences of all these factors vary greatly with the ruggedness of the terrain.

Two local wind surveys have been conducted, one by the U. S. Weather Bureau in 1949-52 at Oak Ridge, Tenn., and the other by Operation Firestop in 1954 at Camp Pendleton, Calif. Unfortunately, much of the data from these surveys cannot be applied to other areas because of the influences of the local terrain and weather conditions. However, as data from additional surveys are accumulated, more and more generalizations can be made that can be applied to other areas. Such wind studies are important in air pollution and smog control.

It is the unusual cases that cause the most trouble. Some recent cases are the 1949 Mann Gulch in Montana and the 1953 Rattlesnake and 1954 Sierra City fires in California. At each of these fires, fire fighters lost their lives when the fire spread rapidly in an unusual and unexpected manner. In the Mann Gulch fire, the unusual currents may have been due to the strong surface winds resulting from descending currents from the high level thunderstorms in that area. In the other two cases, the rapid spread of the fire may have been due to a combination of the normal night downslope air drainage acting simultaneously with a pressure gradient across and through the passes. As more is learned about these wind patterns, more of these unusual fires and their behavior patterns can be anticipated.

Topography.—With the proper pressure gradient across mountain ridges and through passes, strong local winds will be set up as the air flows down the lee side. Examples of such strong local winds are the Santa Ana winds in southern California, the east winds in western Oregon and Washington, and the chinook winds on the east slopes of the Rocky Mountains. These winds have a tremendous effect on fires since they are associated with high temperatures and low relative humidities.

Upper level winds.—As fires spread into the crowns of high trees, a different rate of spread can be expected since the wind speed and direction at this level may be quite different from that near the ground. Also, with burning buildings, the surface winds may have little connection with the fire spread at higher levels. With convection currents carrying burning embers up into even higher levels, the rate and direction of the spread of the fire due to spotting may be entirely different from that which would be expected from just a knowledge of the surface winds alone.

Turbulence.—In addition to the actual local wind patterns, the turbulence or the fluctuations in both the wind speed and the direction must be considered. The magnitude and frequency of these fluctuations have been found to be closely associated with the degree of atmospheric instability. Also, the magnitude and frequency of these fluctuations will be greater at well exposed sites than at well sheltered locations. Mechanical eddies and turbulence can be generated as air flows across and around sharp features of terrain and buildings.

Convection.—Under certain atmospheric conditions, better convection can be sustained which will promote more efficient burning. These conditions are usually associated with atmospheric instability, that is, with near or superadiabatic temperature lapse rates. However, the convection column will not attain great heights if the wind speed increases too rapidly with height. Too strong a wind speed may cause the column to be broken away from its energy source.

Temperature inversions tend to act as a lid on free convection. However, under these conditions, as the free air temperature reaches a certain value or as the energy of the fire becomes great enough, the convection can break through the inversion and can suddenly extend to much greater heights, especially if the atmosphere is unstable above the inversion. When this breakthrough occurs, sudden changes will take place in the fire behavior and the spread.

Much experimental and theoretical work is now in progress on the general problems of turbulence, diffusion, convection and allied problems at many air pollution and micrometeorological projects.

Thunderstorm and lightning.—The high level and often dry thunderstorms present a great hazard in the Rocky Mountain area because of lightning fires. Project Skyfire has been set up in the Northern Rocky Mountain area to study the origin, development, structure and intensity, movement, distribution of these storms, and the possibility of modification of these storms to reduce the lightning hazards.

Meteorological phenomena induced by a large fire.—Once a fire develops, the original wind and temperature distribution around and over the fire will be changed. A complete study of this problem requires accurate and detailed data on temperature, humidity, wind speed and direction, and the composition of the gases in the convection column. From these results, it will be possible to determine the rate of transfer of heat, momentum and the distribution of energy about the fire. In addition to experimental studies at actual fires, much information has been gained from model studies.

Strong indrafts, usually referred to as the firestorm have been observed in the vicinity of some large fires and may become quite appreciable at times.

Conclusion.—As more is learned about the meteorological factors as well as a better knowledge of the fuel distribution and efficiency of combustion, fewer fires will be designated as "blowups." These fires can be anticipated and their behavior patterns expected. However, a vast amount of difficult experimental and theoretical work will be necessary to accomplish this goal.

FIRE EXTINGUISHERS, THEIR TYPES AND USE. IV. FOAM EXTINGUISHERS

A. B. EVERTS
Equipment Engineer, Division of Fire Control, Region 6, U. S. Forest Service

In appearance the foam hand extinguisher resembles the soda-acid extinguisher. It operates in the same manner—by inverting the container to mix the chemicals, which builds up pressure for discharging the foam.

Foam is essentially a Class B extinguishing agent, but it is also effective on Class A fires. In certain types of Class A fuels, such as excelsior, rags, overstuffed furniture, etc., foam is not apt to bring about complete extinguishment because it will not penetrate. Reignition will probably occur. It will help to control, but not extinguish, such fires. Foam should *not* be used on Class C fires.[1]

There are two intriguing characteristics of foam: its expansion, and its insulating qualities. The 2½-gallon foam extinguisher, which is the one we generally think of as a hand extinguisher, will produce 20-22 gallons of foam with a projection of 30-35 feet from the discharge hose. The foam will cling to vertical surfaces, thus providing insulation from the flames. There are instances of 40-gallon foam units that have stopped the spread of well-involved Class A fires by insulating adjoining buildings from the flames. The fire was not controlled, in the general sense, but it was contained.

The foam produced by hand extinguishers should not be confused with the foam used by the fire departments, oil refineries, and naval craft where large volumes of foam are required. That type of foam is a liquid which is mixed with the water at the rate of 6 percent. A special type of nozzle is required. The method of generating foam in the hand extinguishers, or even the 40-gallon wheeled type, is quite different.

The chemical charge contains two packets. One of these, bicarbonate of soda and a foam stabilizing agent, is dissolved in water outside the extinguisher and then placed in the outer compartment. The other charge, aluminum sulfate, is dissolved in water and placed in the inner shell.

When the extinguisher is inverted the two chemicals mix and the resultant reaction generates carbon dioxide gas. Unlike the soda-acid extinguisher, however, the discharge, because of the aluminum sulfate, is foam.

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[1] For more information on classes of fires and types of extinguishers see: *Fire Extinguishers, Their Types and Use. I. Carbon Dioxide Extinguishers, II. The Dry Chemical Extinguishers,* and *III. Water-type Extinguishers,* by A. B. Everts. Fire Control Notes 15(4): 1–5, illus. 1954; 16(1): 9–12, illus. 1955; 16(2): 24–26, illus. 1955.

Sizes of extinguishers.—Hand extinguishers are nearly always of the 2½-gallon size. Wheeled "engines" are usually manufactured in 20- and 40-gallon sizes. Formerly the hand extinguishers were made of drawn copper. New models are made of stainless steel and drawn brass and are tested to 500 pounds' pressure.

How to use the extinguisher.—Carry the extinguisher to the fire. Upend it to start the chemical reaction. For Class A fires direct the stream at the burning material or coat the burning surface.

Because of the insulating characteristics of foam the extinguisher is a good one to use along with a typical Class A extinguisher—soda acid or loaded stream. While one operator applies water directly on the fire, a second operator can insulate the adjacent material by the application of foam.

On Class B fires the method of application varies: on gasoline or oil spills the foam is applied direct; but on fires in open vats or tanks the best method of application is to direct the foam stream against the inside wall of the vat or tank just above the burning surface, so as to permit the foam to spread back over the burning liquid. Extinguishment is by smothering.

Maintenance.—Foam extinguishers should be recharged annually. All parts should be washed thoroughly with water. Check to make certain that the hose is not clogged. Commercial recharges cost about $2.50, if done in a dealer's plant, but the recharge chemicals can be purchased for about 50 cents. If you do your own recharging, mix the chemicals in accordance with the instructions on the packages.

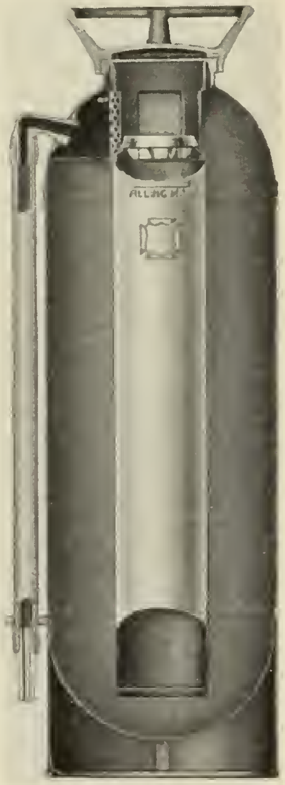

FIGURE 1.—Cutaway photograph of a foam extinguisher showing the inner container.

WARNING: Do not use antifreeze ingredients in a foam extinguisher. To do so will reduce the effectiveness of the discharge and may result in internal corrosion which will make the extinguisher dangerous to use.

Foam extinguishers need to be protected from freezing.

Summary.—Foam extinguishers (a) should be used on Class B fires, secondary on Class A fires; (b) need annual recharging at a commercial cost of $2.50 or a do-it-yourself cost of 50 cents; (c) cost around $30 (charged); (d) have length of discharge stream of 30-35 feet; (e) produce 20 gallons of foam; (f) will freeze (Note: Do not use antifreeze salts).

A CASE FOR SIMPLIFIED FIRE EXTINGUISHERS[1]

CALVIN H. YUILL
Director, Fire Technology, Southwest Research Institute

Have you ever tried to use a fire extinguisher only to find that it was designed for a different kind of fire? Or discovered that a particular extinguisher operated differently from any that you had used before? Or breathed the deadly fumes generated in using some extinguishers? Or spilled acid on your clothing while servicing another type of extinguisher? All of these mishaps, and worse, have happened to many people.

Most fires could be stopped in their early stages by judicious use of a hand fire extinguisher. Prompt action by an alert employee could save his job and his employer's business. It is estimated that nearly a third of all fires—more than two-thirds of fires in industry, are extinguished with hand operated fire extinguishers.

This record is impressive when considered by itself. In relation to the annual toll of fire, it loses much of its significance.

Our direct fire losses today amount to over a billion dollars a year and indirect losses are several times that figure. Some 12,000 people lose their lives in fire and thousands more are severely burned each year. Every possible means of reducing these fire losses is worth considering. Simplification of the design of fire extinguishers is one avenue of approach that would be worthwhile.

There are eight types of fire extinguishers commonly sold today. Five can be used on fires in ordinary combustibles such as wood, cloth, paper and rubbish. Five are available for use on burning oils, greases and other flammable liquids. There are three types available for fires involving electrical equipment.

Some extinguishers can be used on two different kinds of fire. None can be used successfully on all three.

Confusion Confounded

Among the eight basic types of extinguishers are a multitude of operating techniques. One recent publication of a recognized laboratory illustrates four methods of actuating carbon dioxide extinguishers and five methods for operating dry-chemical extinguishers. Here indeed is confusion confounded. Is it any wonder that many fires get out of hand while the bewildered worker tries to figure out the method of operating a particular extinguisher.

Recognizing the value of present-day fire extinguishers, it is believed their utility could be measurably increased if the eight types could be reduced in number and the operating mechanism standardized.

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[1] Reprinted from *Tomorrow Through Research*, by permission of Southwest Research Institute, San Antonio, Tex.

Let us explore the possibility of reducing the number of fire extinguishers by examining well established characteristics of each. Extinguishers for fires in ordinary combustibles are a good starting point.

The common soda-acid extinguisher is probably the oldest and most widely used. This unit, however, must be inverted so that the sulphuric acid will mix with the bicarbonate of soda solution to generate gas to expel the mixture. It must be emptied, washed and recharged each year using care to avoid spilling the acid. It is good only for fires in ordinary combustibles.

Foam extinguishers operate much as the soda-acid type but with aluminum sulphate in place of sulphuric acid and a stabilizer is added. The same objections to method of operation and maintenance apply plus the fact that the sticky foam solution is hard to clean up after the fire is extinguished. This extinguisher is suitable for use on both combustile and flammable liquid fires. Since the solution is conductive, it should never be used on fires involving electric equipment.

Another extinguisher is the "loaded stream" type. Here a proprietary liquid is expelled by gas from a pressurized cylinder. There is a wide divergence of opinion on the merits of this extinguisher and it is not recognized by one of the two large laboratories engaged in testing and approving fire extinguishers. It also can be used on combustible and oil fires but not on fires in electrical equipment.

Another common type is the water pump tank. For outdoor work—on grass, brush or trash fires—this is unexcelled because it can be refilled quickly and kept in constant operation. However, the pump tank requires more maintenance than many types and is not convenient for use on indoor fires.

The charged water extinguisher uses pressurized gas or a small gas cylinder inside the body of the unit and plain water. This type of extinguisher is easy to use, clean and simple to maintain. Again, it is limited to use on fires involving combustibles.

Simplicity Is Possible

From a purely functional point of view, the number of extinguishers for use on fires in combustibles could be reduced from five to one.

Now let us look at the five extinguishers sold for use on oil, grease or gasoline fires. As we have just seen, the foam and "loaded stream" types have definite drawbacks.

The vaporizing liquid extinguisher using either carbon tetrachloride or chlorobromomethane as the extinguishing agent can be purchased from the mail order house, the corner drug store or neighborhood hardware store. Few of the people selling or buying this type of extinguisher realize the high toxicity of fumes produced by the liquids used. Many health and medical authorities condemn this type of extinguisher. We would do well to eliminate it from the list.

This leaves the carbon dioxide and dry chemical extinguishers and a choice between these two is difficult. For many, the carbon dioxide extinguisher is attractive because it leaves no residue. On the other hand, trained fire fighters often prefer the dry chemical type for certain fires because of its lesser tendency to "flash back" with use.

Finally there are three common types of extinguishers recommended for electrical fires. All three can be used on oil fires, and have been considered already. Leaving out the vaporizing liquid extinguisher for reasons already stated we have left the carbon dioxide and dry chemical types.

We have then eliminated five of the eight common types of fire extinguishers for use in buildings and have left only three:

1. Charged water extinguishers for fires in combustibles.
2. Carbon dioxide and dry chemical types for oil and electrical fires.

Since the last two types are rather close in performance, it is quite possible that one of the two could be adopted as a standard. Exhaustive testing under a wide variety of conditions would be necessary to establish a preference.

A Plea for Uniformity

Actually, substantial differences in performance do not exist and selection of any one type for each of the three kinds of fires is based largely upon personal preference.

Now how about the operating mechanisms of these basic types—could they be standardized? The answer is an unqualified yes, and such standardization is not only possible but has already been done.

One manufacturer has on the market charged water, carbon dioxide and dry chemical extinguishers that are practically identical in appearance and operation. The method for operating them is so simple that it is obvious even to the uninitiated.

There are many reasons that would explain the present situation. Tradition, customer demand, or competition, would impede a change in established practices. Nevertheless, from the viewpoint of public safety, much would be gained from the transition. Confusion in customers' minds would be eliminated and the stage set for much wider use of this important fire fighting device.

Here indeed is a challenge to industry. An opportunity to serve the public better and to expand markets at the same time. At the same time thought should be given to further improvements such as lighter weights, better design—even an all purpose extinguishing agent. These things will come in time—the opportunity for simplification is here today.

BUNK TOOL RACK

LLOYD E. MYERS

Forest Fire Warden, Division of Forestry, Ohio Department of Natural Resources

Storing handtools in a warehouse is frequently a problem. Fire rakes, for instance, can be dangerous when hanging from the wall. One solution is the bunk tool rack. It is cheap, and can be easily moved from one place to another (figs. 1 and 2).

The frame is made of 2 by 4's in the form of a double bunk bed. Four pieces 6 feet long serve as side rails, 4 pieces 36 inches long as legs, and 4 pieces 32 inches long as crosspieces. The bottom and top rails are 22 inches apart. Cyclone wire stretched and stapled over top and bottom rails will hold fire rakes, broom rakes, swatters, axes, shovels, and about any other handtool used in fire fighting.

Where there are large numbers of tools to be stored, bunks can be laid on their sides and stacked one on top of the other, or stood on end to save space.

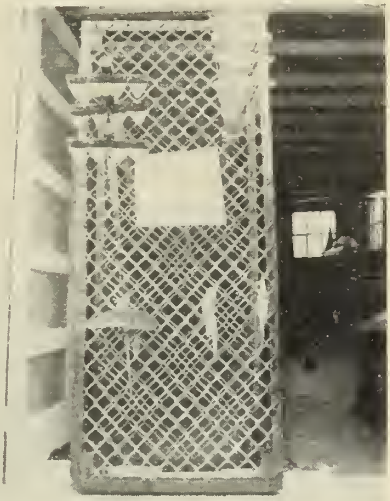

FIGURE 1.—Rack on end.

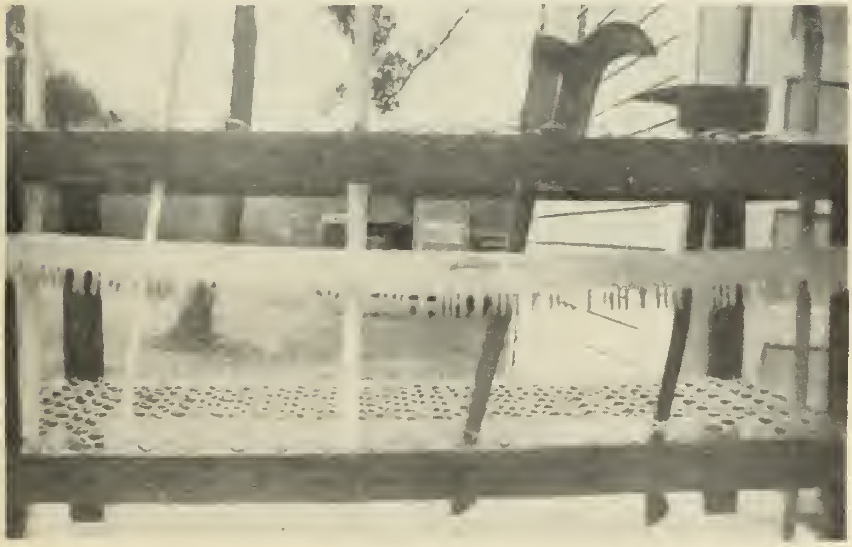

FIGURE 2.—Bunk tool rack in normal position.

FIRE SUPPRESSION UNIT FOR THE SMALL FOREST

Don M. Post

Assistant Professor, School of Forestry, University of Florida, Gainesville, Fla.

At a cost of less than $700 this fire protection unit may be the solution to your problem. This machine was designed for farmers and owners of small forests who can't justify a high capital outlay for fire protection equipment.

Tractor drawn, the unit has a 325-gallon tank with a 1-inch, high-pressure centrifugal pump and a 6-horsepower, air-cooled motor (fig. 1). The pump is capable of delivering 5 to 65 gallons per minute at 20 to 140 pounds pressure, 16 minutes supply of water at full spray at 20 gallons per minute. A gear type pump and motor, or power takeoff arrangement on the tractor could be substituted for the centrifugal pump and motor at a substantial reduction in cost. However, when the tank is to be refilled from streams or pond with sandy bottoms the gear type pump may not be satisfactory.[1]

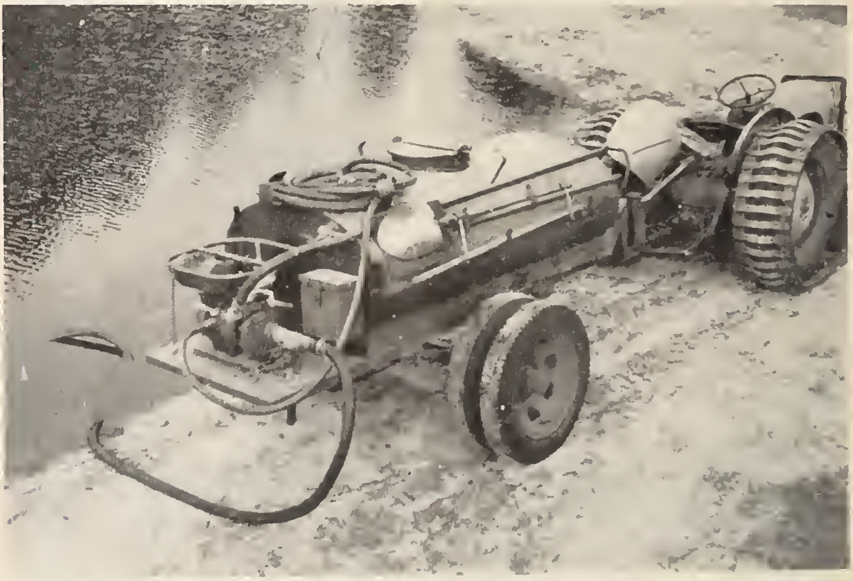

FIGURE 1.—Suppression unit ready for use. At a 10-foot lift the tank can be filled in 7 minutes.

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[1] Further details concerning the construction of this tanker-trailer may be obtained by writing the author.—Ed.

The unit weighs 654 pounds empty, 3,324 pounds fully loaded. It can be towed easily by a medium-size farm tractor through most woods areas. For use along woods roads a pickup truck would be suitable (some States require trailers grossing over 1,500 pounds be equipped with approved brakes).

Forest fire suppression is only one use to which this unit lends itself. It can be used to protect farm buildings or could serve as a supplementary unit for the fire department of a small community. It can also be used to irrigate small nurseries or gardens, or clean logging or farming equipment.

* * *

Ash-Tray Smokey Bear

The life-size Smokey Bear poster makes a very good "Use ash tray" fire prevention sign that is also handy at service stations. The cut-out Smokey and cubs are mounted on plywood with a large "Please Prevent Forest Fires" across the bottom. At Smokey's left paw is mounted a gallon oil can, with "Empty Ash Trays Here" above it. The plywood is cut ¼ inch larger than Smokey and dark brown paint is used to trim. A transparent sprayed-on plastic coating to preserve Smokey is planned. The sign stands by itself and is placed in a convenient location. Demand for the signs exceeds supply.—MILO PETERSON, *Area Forester, Iowa Conservation Commission.*

CANOE SMOKECHASER TOOL UNIT

W. W. Wentz

District Ranger, Green Mountain National Forest

Smoke chasing along the relatively inaccessible fourteen miles of shoreline of the Somerset Reservoir in the Green Mountain National Forest is most effectively carried on by canoe transported crews. In waters frequently quite choppy for canoe travel a unit was necessary to provide safe transportation of tools in the limited space available and to protect the somewhat fragile structure of the canoe from damage. A lightweight, compact unit was constructed to provide these safeguards as well as to speed up the time involved in launching the fully equipped canoe (fig. 1).

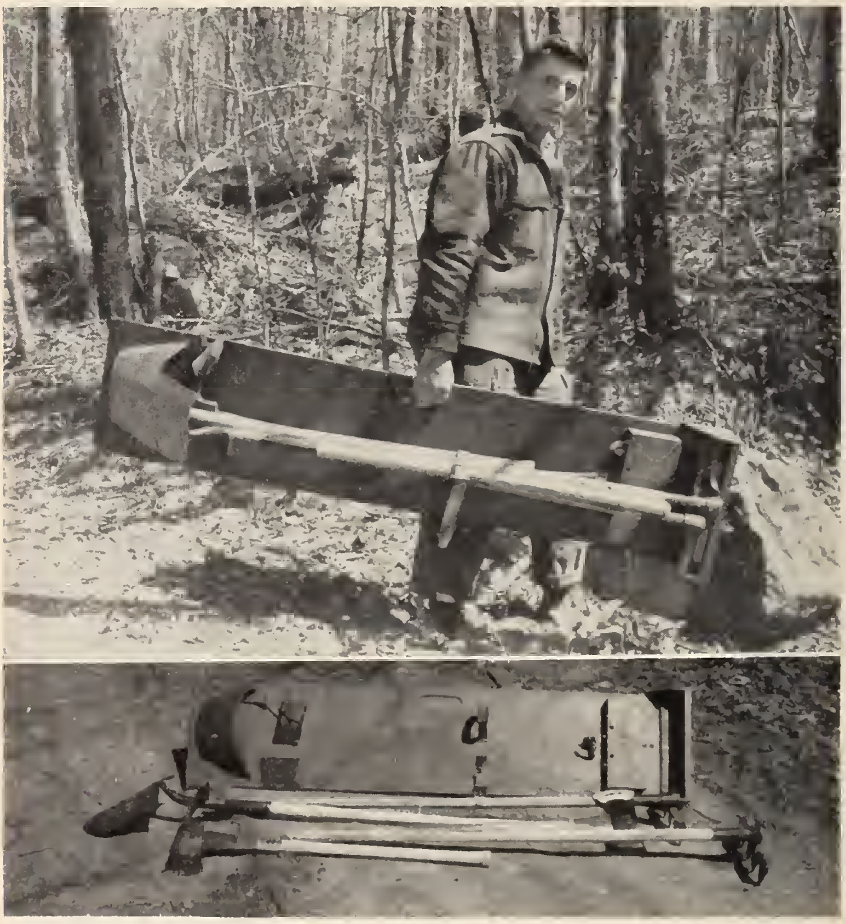

Figure 1.—Smokechaser tool unit designed primarily to lie flat in a motor-driven canoe.

On a base of salvaged ⅜-inch fir plywood a sheet of light gage metal was formed around the head of a shovel and tacked in place. A light plywood box the size of a double-bitted head was screwed to the board and a buffer strip of 1- by 3-inch spruce was fastened to the end of the base to prevent the council tools from sliding. Another piece of light metal was formed around the ax bit of the pulaski tool under the shovel handle and tacked in place. The other head of the pulaski tool was sheathed in a single-bitted ax sheath which is secured to the board. In the center of the board a short length of leather strap with a buckle was screwed and a "U" bolt placed to receive a snap swivel on the end of the strap. The strap firmly secures all tools together and on the board. A carrying handle has been cut at the balance point of the unit for ease of carrying.

The unit as designed fits a local need for use in a canoe with a 3-man capacity but could be well adapted to provide a lightweight complete unit placed in other types of vehicles on a temporary emergency basis.

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Coronado Fire Camp Table

Until recently the Coronado National Forest fire camp table consisted of an assorted pile of lumber, cut to various lengths and put together at the selected camp with hammer and nails. This did not produce a very serviceable table and there were far too many pieces of lumber to keep track of. Oftentimes, the carpentry was not of the best. It was decided that something better might be designed. The table now used on the Coronado is considered far superior, goes together in a fraction of the time, and is far sturdier. It is made as follows:

Cut in half a piece of ¾-inch plywood; 4 by 10 feet is a good size though it may be larger or smaller. Join the two pieces, which are 4 by 5 feet, with two heavy strap hinges, about 12 inches long. Attach ½-inch pipe flanges near all corners of both pieces of the plywood; cut eight pieces of ½-inch pipe to about 32 inches, threaded on one end. It is very important to use stove bolts that fit the holes in the hinges and the flanges, and to secure the nuts by lightly riveting them. The hinges should, of course, be mounted on the underside of the plywood so they are not in the way on the tabletop. If single tables are desired hinges are not necessary.

To set up the table, simply screw the pieces of pipe in the flanges, turn the table over, and it is ready for use. No tools are needed to set up the table, hand twisting of the pipes is ample.

To transport the table in a truck or pickup, fold the two sections together and tie the pieces of pipe in a bundle. The whole thing takes up very little room; several tables may be carried if desired.—GILBERT SYKES, *District Ranger, Coronado National Forest.*

PROTECTOR FOR HOSE ACROSS ROADS

Rolfe Anderson

District Ranger, Siuslaw National Forest

In 1954 District Assistant Willis Horner and District Ranger Rolfe Anderson of the Hebo District devised a protector for hose lines lying across roads where traffic must be kept moving during the operation of a pumping system.

The hose protector was constructed from 4 pieces of 4- by 12-inch spruce plank cut 42 inches long, beveled on the ends for easy crossing by trucks, and with a cutout through the center to accommodate one or two 1½-inch hose lines. For dual-tired vehicles such as logging trucks double planks are necessary. These may be hinged so they will stay parallel and in place while in use and yet can be folded for ease in transporting (figs. 1 and 2).

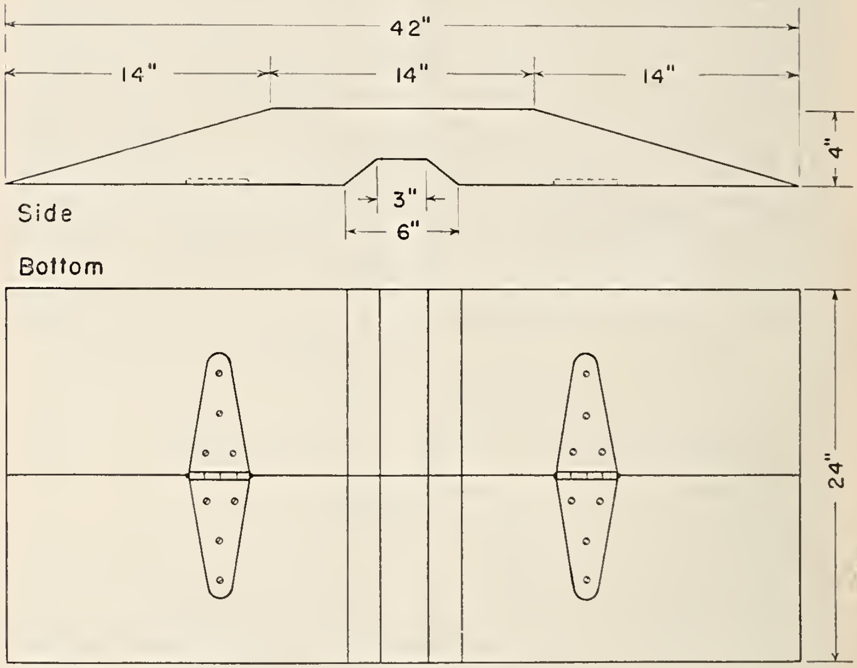

Figure 1.—Hose protector construction details.

These hose protectors have proved their value on the Hebo Ranger District and elsewhere on the Siuslaw; they fill a definite need on slash burning operations or fire fighting when it is necessary to lay hose across roads without interrupting traffic, or risk-

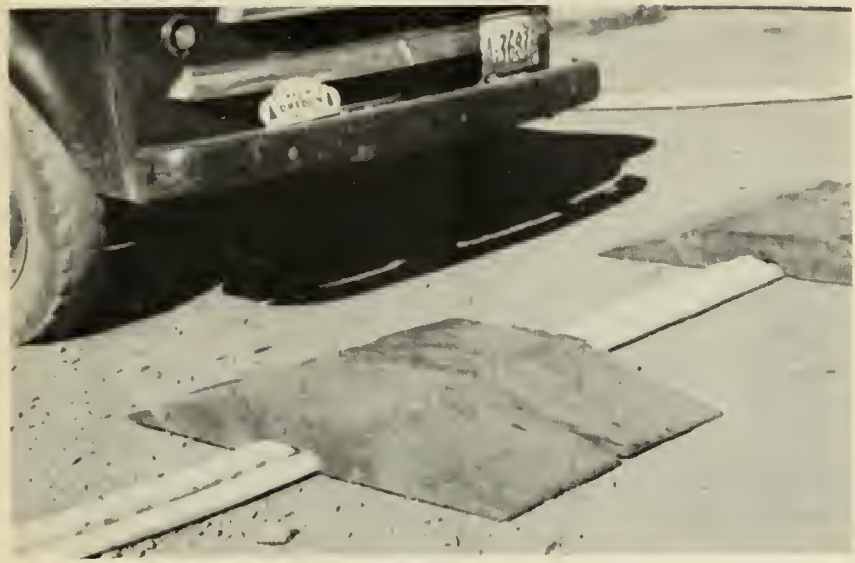

FIGURE 2.—Hose protector in place.

ing broken hoses. Two primary values are simplicity of construction and the fact that, once in place, they "stay put" without the constant attention so commonly needed with planks and other usual protectors.

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Stop Power Saw Fires Tags

In order to reduce the number of man-caused fires started in Oregon's forests by power saws the Keep Oregon Green Association has prepared a red tag, approximately 3 by 6 inches, listing fire precautions. Quantities of this tag will be distributed to power saw agencies and their repair shops in Oregon so that a tag can be attached to each power saw sold or repaired. District wardens, U. S. forest rangers, and U. S. Bureau of Land Management foresters will have tags for distribution, and the State Forester plans to include one in every envelope that contains an operating harvesting permit for 1956.

These are the fire precautions for power saws listed on the tag:

1. Place power saw on mineral soil when fueling, NOT in dry litter or slash.
2. Permit hot power saw to cool two or three minutes before refueling.
3. Use non-spill gas can to fill tank and avoid spilling of inflammable fuel.
4. Use proper oil and gas mixture to minimize carbonization.
5. Do not start power saw at place of filling.
6. Keep power saw clean of sawdust and inflammable material.
7. Keep muffler on the power saw and in good condition.
8. Don't operate your power saw if it is backfiring.
9. Keep spark plugs and wire connections tight.
10. Keep a filled fire extinguisher and shovel with power saw at all times.
11. Clear inflammable material from point of saw cut.
12. Put out any fires started and report them to the foreman, together with causes.
13. All fires should be promptly reported to the proper forest protection agency.—ALBERT WIESENDANGER, *Executive Secretary, Keep Oregon Green Association.*

TELEVISION TESTED FOR FOREST FIRE DETECTION IN CALIFORNIA

JOHN HASTINGS
State Forest Ranger, California State Division of Forestry

As a part of its program of equipment development and research, on June 7-10, 1955, the California State Division of Forestry participated with the Hancock Electronics Corporation of Oakland in a test and demonstration of closed circuit industrial television as adapted to forest fire detection.[1] This demonstration served the twofold purpose of acquainting the Division of Forestry with the possibilities of television for forest fire detection and demonstrating to the manufacturers some of the requirements of a good fire detection system and the ability of their equipment to fulfill these requirements.

No specific equipment was developed for this test and all equipment used was that which had been previously developed for other uses. However, it was stated that a complete installation embodying any features that we might desire could be constructed.

Prior to the test, a platform was constructed at the 90-foot level of a 100-foot steel lookout tower 200 feet from our El Dorado Ranger Unit headquarters. The platform was constructed so that it projected out about 5 feet beyond the west side of the tower and permitted a camera sweep of about 270 degrees free from interrupting tower girders and framework.

The television installation consisted of a television camera, control unit, and monitor mounted upon the tower platform and linked by coaxial cable to three 12½-inch monitors in the nearby dispatch office. Of the three monitors in the dispatch office, one was used by the lookout-observer, one was used with a 4 x 5 Speed-Graphic camera to record what was observed upon the monitor screen, and one was used to film a limited amount of 16-mm. movie film.

In this demonstration, all camera movement was controlled by the lookout-observer using a small remote control unit adjacent to the monitor. The remote control unit consisted of a small box with two momentary switches, one moved up or down for tilt control and one moved left or right for azimuth control (fig. 1).

As there was no provision for registering the azimuth at which the camera was pointed, it was necessary that the lookout-observer be able to orient himself by familiarity with the terrain as it appeared upon the monitor screen. In order to aid in this orientation and to facilitate evaluation of the scene viewed, prior to the start of viewing, all of the permanent mill smokes in the area and

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[1] Several other States have made or are making similar tests. Louisiana is now operating a TV lookout alongside a manned lookout for a season's evaluation. Two problems still to be solved are (a) more definite determination of the effectiveness of TV observations at maximum distances, and (b) best method for indicating azimuth, a requirement that has a direct bearing on cost of an installation.

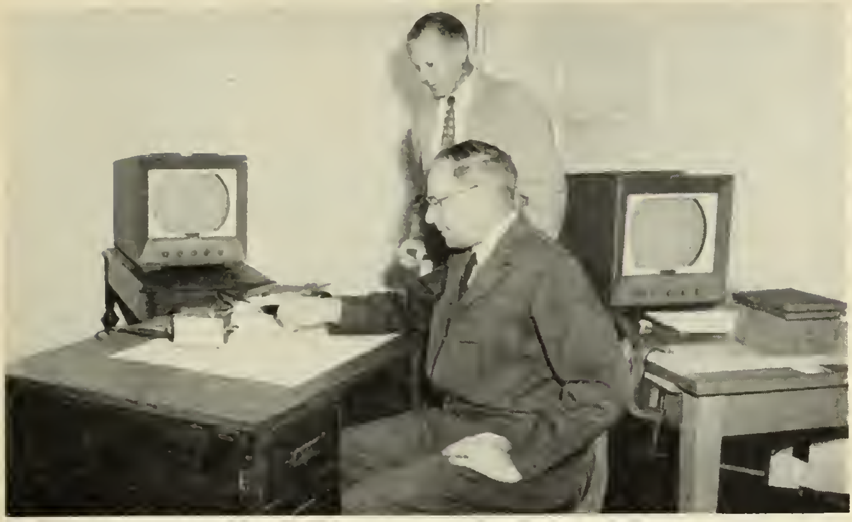


FIGURE 1.—Monitors used in viewing by TV lookout-observer and in taking pictures of scene observed; remote control unit on desk.

certain terrain features were plotted upon a map and identified as to distance and azimuth from the camera. In addition, possible points for the ignition of test smokes were located.

During the period of the test and demonstration, observing was done using 8-, 16-, and 20-inch focal length telephoto lenses (fig. 2). With each lens, prominent terrain features and all of the permanent mill smokes in the area were observed and photos of their appearance upon the monitor screen were made. The mill smokes were located at varying azimuths and at distances of 6 to 16 miles. Test smokes were ignited at distances of 7, 10, and 13 miles to test the ability of the lookout-observer to pick them up. In all instances, when the test smokes were ignited, the camera was pointed in the direction of the expected smoke.

Results of this limited test have indicated to us that the television camera is a feasible means of fire detection although at this time we did not have the opportunity to make a firm comparison between the merits of a manned lookout tower and a TV-observer. Further tests will be needed to determine the comparative efficiency of each method as well as the relative costs of each system.

The 8-inch lens appeared limited to about 10 miles for picking up small smokes and detail although the field of vision seemed good for routine scanning. The 16- and 20-inch focal length lenses brought detail at distances not reached by the 8-inch lens, but they were not satisfactory for scanning. Haze penetration was improved by the use of an improvised filter.

Best results would appear to be obtained by the use of a camera with a multiple lens installation—a 6- to 8-inch focal length lens for general scanning rotated at a rate such that the observer can spot small smokes with a minimum of difficulty and

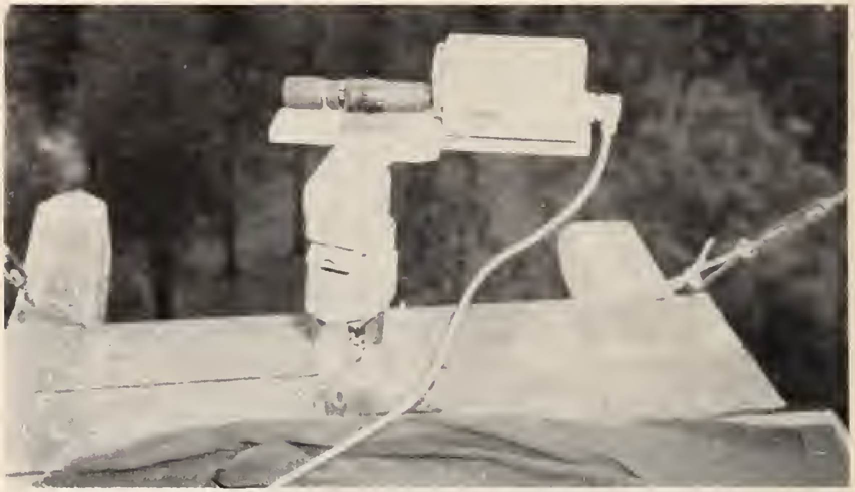


FIGURE 2.—TV camera with 8-inch focal length telephoto lens installed.

a lens of 16- to 20-inch focal length for close scrutiny of specific areas, particularly out towards the edge of the 15-mile radius. Use of proper filters will probably materially improve the visibility during hazy conditions.

Some problems that still need to be solved are these:

1. What is the best lens to use for routine scanning considering field of vision and magnification.
2. Given the desired lens, what is the optimum rate of scanning that will permit satisfactory coverage of the area and easy observation of small smokes.
3. What are the desirable filters to use.
4. How many monitors can one observer watch and what are the fatigue factors involved.

The various problems encountered during this test were discussed with the manufacturers. None of them appear to be insurmountable. As the problems are overcome, it is the intent of the California Division of Forestry to continue to evaluate the television camera as a means of providing a primary detection service or supplementing the existing system.

ACCIDENT FACTORS ARE "DANGEROUS DOMINOES"

JOSEPH RADEL

Safety Officer, Region 5, U. S. Forest Service

[Adapted from a talk given by the author at the California Region's 1955 Supervisors Meeting at San Francisco.]

A well-known author in his book on industrial accident prevention used dominoes to illustrate accident factors. We have borrowed the idea but adapted it to Forest Service use. If these principles of dangerous dominoes are understood they can be further adapted to our use so that current gains in safety will be continued. There is every good reason, in fact, to look forward to the day when Region 5 will practically eliminate accidents. But first let us look back at our injury frequency rate.

There has been a constant downward trend in injury rates since 1947. From 38 lost-time accidents per million man-hours worked in 1947 to just slightly over 10 in 1954 for an all time low represents a 74 percent reduction in injury frequency. This constant betterment in our record of employee safety represents hard work, ingenuity, and leadership by many people in the Region.

It has been said, "There is no hope for the satisfied man." We believe it true for us in safety, too, so our goal is an injury frequency of 5 or less. By process of extrapolation we can extend the present average trend to show that by 1959 the Region should be below 5. This means less than 30 lost-time accidents annually for the entire Region. A worthy objective which, when reached, will mean we have eliminated much suffering, grief, and financial hardship for our people.

One of the most successful salesmen in America lists determination and willingness to pay the price as qualities needed to achieve our goals, whether it be in our personal or official life. We can reach our goal in safety if we want to eliminate injuries enough to make accident prevention a vital part of all activities.

Accident factors occur in a given sequence to produce a final result. Like dominoes standing in a row when the first is tipped over it will cause the rest to fall successively. Injury or death is the final domino. Preceding the injury is occurrence—an accident which may or may not cause an injury. (For example, the top coming out of a burning snag, which narrowly misses the fire fighter, is an accident but in this case doesn't result in injury. The next time a similar occurrence might cause a fatality.)

Preceding the occurrence or accident there is in every case either an unsafe act of a person or persons (such as carrying an ax on the shoulder or using a file without a handle) or an unsafe physical or mechanical condition (unguarded machinery, mushroomed striking tools, etc.) or both. Back of these stand several more dominoes—the reasons for the unsafe act or hazardous condition. Sometimes we refer to these dominoes as "the cause behind the cause." So we have our train of dominoes on end, culminating in an injury. Our aim is, of course, to discover the key dominoes which cause accidents and remove them.

Key Dominoes

Environment, heredity, habit: these are the first three dominoes. They influence production as well as accidents. Environment is defined as "the external conditions and influences which affect the life and development of people." These influences, for good or bad, make their impact before the Forest Service gets the employee. Certainly there is no question about hereditary traits, those physical characteristics transmitted from parent to offspring. Habits, good or bad, are also pretty well ingrained by the time we hire an individual. Does this mean we are helpless? No, I don't think so. Our choice here falls within a solid recruitment program, and like the two poles of a battery has a positive and negative side. Positive will result in development of methods to attract the best, whether they be seasonal or year-round professional and nontechnical people; negative, in rejecting those not fit for Federal service whether it be for a few weeks or for a lifetime career.

Recruitment

In presenting a guide for a positive program of recruitment Clare Hendee, our former regional forester, said, "Recruitment of qualified people who can be trained to give loyal, efficient public service is one of the Region's basic problems. We all agree that public service goals will best be achieved with and through good people . . ." He also listed several recruitment factors, such as (1) attitude which demands the best; (2) arrest records held to a minimum; (3) physical exams for employees; (4) standards of discipline kept high but fair; (5) set a right climate for growth and satisfaction on the job; (6) faith in the willingness of able employees to be loyal and enthusiastic.

In Region 5, seasonal personnel outnumber yearlong personnel two to one. Counting turnover we hire more than 3,000 seasonal workers each year. Many of these come from the city where they have had little or no opportunity to observe us or our work. Integrating such workers into the Forest Service for top public service is extremely difficult. Job training, orientation, supervision and, perhaps most of all, safety become a tremendous challenge to those of us who supervise. Thus we can't afford the additional handicap of using inferior parts when trying to weld a striking force together under these circumstances. Perhaps we can't always compete salarywise with private industry, but we can use our ingenuity to sell other desirable benefits and opportunities available to employees who work for the Forest Service.

We no longer automatically get the best forestry graduates from the schools. A prominent forestry school recently wrote us concerning this very problem. Despite the urging of the entire forestry school staff, less than half of the students took the "JF" examination in 1954. "A decade or two ago," the dean said, "most of our students wanted a Forest Service career. Today this is changed. Private industry is competing for and getting some of the best forestry graduates."

The same situation holds true for engineering graduates. This situation means many things in terms of recruitment ingenuity—such as adequate housing, treatment on the job, climate favorable to growth, and satisfaction on the job. It will also have to mean full appreciation of student employment as a significant step in recruitment of year-round personnel. For, after all, how we treat the student and the opportunities and challenges presented during summer employment may be the deciding factor as to whether or not he desires to make the Forest Service his career.

Unsafe Conditions

Here we have one of the less subtle dominoes. An unsafe mechanical or physical condition is simply defined as "a condition which might have been guarded or corrected." From the standpoint of accident prevention this is the one sequence factor most easily corrected or changed. We have done well in eliminating this deadly domino but not well enough. I have yet to go on one forest without finding at least several instances where safety engineering could be improved. Last year I found these "unsafe conditions" which could have been eliminated but which were not: Unguarded belts, inadequate machine guarding, mushroomed tools and other defects of tools, unsafe overhead storage, poor lighting, poor housekeeping, no goggles sent out to a fire for use with grinders, ungrounded electrical equipment, electrical outlets and pull chains accessible from shower stall, dangerous location of garage in relation to a busy transcontinental highway.

Unsafe Acts

An unsafe act or faulty behavior is usually associated with some degree of physical hazard. Thus this dangerous domino is usually found in combination with other equally dangerous dominoes. In the Forest Service, however, regardless of the good job we might do in safety engineering we still have the steep slope, burning snags, rolling rocks, explosive brush fires, scaling logs at a busy landing, driving trucks and cars over winding mountain roads, and many other highly hazardous jobs.

Obviously we cannot level the slope or put a machine guard around a man to protect him from rolling rocks if his job causes him to be on a steep rocky slope. Nor can we at this stage in our development of fire fighting techniques prevent the smoldering brush fire from taking off when weather factors are right. Therefore, in the Forest Service, we must not only know and practice commonly accepted safe procedures but, in addition and under certain circumstances, we must be familiar with the techniques of "injury avoidance." There is a difference. Let me illustrate.

A worker uses a power grinder. Since he can finish the job in about 3 seconds he makes a decision not to use the goggles. He takes a chance and a piece of steel flies into his eye, causing a painful and lost-time injury. He definitely committed an "unsafe act" by violating a commonly accepted safe procedure—in this case his decision not to wear goggles. An unsafe act can be something a person does or something he should not have done or perhaps done differently. He may have done so deliberately with full knowledge that he was doing something unsafe or he may not have known. The criterion here is usually "would a cautious and well-trained person have done the same thing under the same circumstances" or in the above example used the grinder without goggles?

Good injury avoidance techniques can be illustrated by the precautions a well-trained fire boss will take when leading his men down to a spot fire in brush. Under certain circumstances he knows that such action would be suicide. Therefore, before he takes his men in on such a mission he considers wind, humidity, slope, density of brush, escape routes, lookouts, experience and physical condition of his men. His personal action in taking his men to such a fire should not be considered an unsafe act merely because it is hazardous. If proper precautions are taken, we have here an illustration of a Forest Service injury avoidance technique. If because of lack of know-how the fire boss took his men into a situation which later developed into a trap and several were seriously burned, we have an illustration of an unsafe act. Many actions are normally quite safe, such as smoking, for example. However, smoking in an oil refinery or an explosives plant could be the means of blowing you to Kingdom Come!

An unsafe act domino stands in our way every time an accident occurs and it is evident that there was a reasonable and less hazardous way that could have been followed. If the hazard remains despite our best efforts to eliminate it and the job has to be done, then we train, supervise, demonstrate, inspect, and otherwise use all the safety gadgetry at our command to sell injury avoidance. Sometimes this domino isn't removed because of haste, fatigue, or just downright disregard for common sense. Usually, however, our people commit unsafe acts and take chances because they don't know. The slogan on the fire tool decal "Be safe—do it right" could just as well read "Do it right and be safe."

An analysis of Forest Service accidents for 1954 reveals that over half of our injuries were a result of not knowing how to avoid injury while performing a hazardous or semihazardous job. The reason may have been a physical defect such as poor vision or hearing; it may have been mental, such as an inclination to take a chance, or, as is too often the case of our seasonal employee, lack of experience and understanding of the job.

Each one of us can think back on our own Forest Service experience. I believe you will agree that most, if not all, of our serious and fatal injuries can be eliminated when we determine to plan for safety and then insist on systematic training in the actual performance of safe work practices. Nonroutine work such as we do in the Forest Service can be performed safely if supervision will insist upon a high degree of technical know-how, and then follow through to see that we are practicing that which we know. Let's rid the Region of all "Dangerous Dominoes"!

INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page.

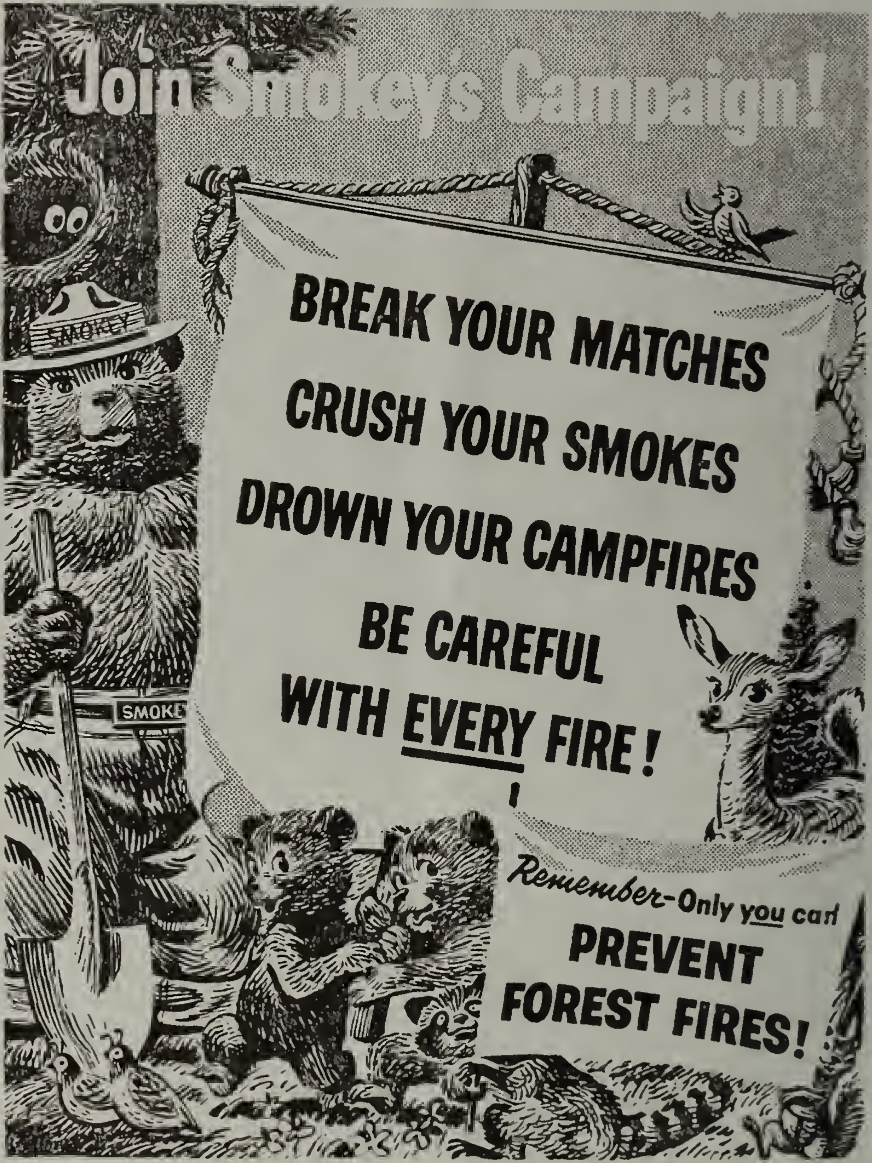
The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

Any introductory or explanatory information should not be included in the body of the article, but should be stated in the letter of transmittal.

Illustrations, whether drawings or photographs, should have clear detail and tell a story. Only glossy prints are acceptable. Legends for illustrations should be typed in the manuscript immediately following the paragraph in which the illustration is first mentioned, the legend being separated from the text by lines both above and below. Illustrations should be labeled "figures" and numbered consecutively. All diagrams should be drawn with the type page proportions in mind, and lettered so as to permit reduction. In mailing, illustrations should be placed between cardboards held together with rubber bands. *Paper clips should never be used.*

When Forest Service photographs are submitted, the negative number should be indicated with the legend to aid in later identification of the illustrations. When pictures do not carry Forest Service numbers, the source of the picture should be given, so that the negative may be located if it is desired.

India ink line drawings will reproduce properly, but no prints (black-line prints or blueprints) will give clear reproduction. Please therefore submit well-drawn tracings instead of prints.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